Greenhouse Gas Emission Trends and Projections for Missouri, 1990-2015 Technical Report

Chapter 4

Projections of CO_2 Emissions from Fossil Fuel Combustion in Missouri End-Use Sectors, 1997-2015

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In 1990, Missouri consumers and businesses used about 1,322 trillion Btus of fossil fuel for energy, resulting in about 111.5 million tons of CO_2 emissions. In 1996, Missouri consumers and businesses used about 1,570 trillion Btus of fossil fuel for energy, a 19 percent increase over 1990. Growing at an average annual rate of 3.1 percent, CO_2 emissions increased by about 22.5 million tons to about 134 million tons of CO_2, a 20 percent increase over 1990 emissions.

Under business-as-usual conditions, energy use and CO_2 emissions in Missouri will probably continue growing over the next 20 years, although not as rapidly as between 1990 and 1996. Midrange scenarios developed in this chapter project a 50 million ton increase in energy-based CO_2 emissions between 1990 and 2015, with these emissions totaling about 161 to 163 million tons in 2015. Total greenhouse gas emissions in Missouri are projected to reach between 163 and 180 million tons in 2015; CO_2 emissions from energy will contribute a large and increasing share of that total.

Chapter 2 projected future Missouri utility energy use and CO_2 emissions from fossil fuel combustion through 2015. Table 1 lists historic and projected estimates of utility energy consumption that were developed using estimation methods described in Chapter 2.

Table 1 - Estimates of historic and projected fossil fuel combustion by Missouri utilities in 1990, 1996 and 2015

Units: Trillion Btus

	Total	Natural Gas	Petroleum	Coal
1990	507.6	3.6	1	503
1996	612.5	4.9	1	602
2015 - SS direct	659.3	5.3	2	652
CT direct	714.9	14.8	1	699
CT sales - LowNG	856.0	14.8	1	840
CT sales - HighNG	829.7	96.0	1	733
AEO direct	786.3	30.6	3	753
AEO sales - LowNG	790.2	30.6	3	757
AEO sales - HighNG	755.4	96.0	3	657

The SS direct, CT direct and AEO direct methods are based on estimating CO_2 emissions directly from historic or U.S. Energy Information Administration data, using the Steady State (SS), Continuing Trend (CT) or Annual Energy Outlook (AEO) methods described in Chapter 2. The "AEO sales" methods and "CT sales" methods estimate energy use indirectly, based on electricity sales projections derived using the AEO or CT methods.

Chapter 3 extends these projections to include emissions from Missouri's "end-use" sectors — the transportation, residential, commercial and industrial sectors. Part 1 of this chapter uses the SS, CT and AEO direct methods to project end-use sector energy use through 2015, summarized in Table 2. Part 2 estimates end-use sector CO_2 emissions based on their projected primary fossil fuel energy use.[1] Part 3 estimates the allocation of utility CO_2 emissions to end-use sectors based on their use of electricity.

[1] Strictly speaking, the table estimates primary energy consumption based on fossil fuel *combustion*. At present, nearly all primary energy use of fossil fuels in Missouri is based on combustion, which releases some of the heat content of the fossil fuel as usable energy but also releases CO_2 as a byproduct. In the future, fuel cells will offer an alternative technology for utilizing the energy content of fossil fuels and other energy resources.

Table 2 - Historic and projected fossil fuel combustion in Missouri, by sector and fuel, 1990, 1996 and 2015

Units: Trillion Btus

	1990	1996	SS direct	CT direct	CT sales LowNG	CT sales HighNG	AEO direct	AEO sales LowNG	AEO sales HighNG
Fossil fuel use, by sector and fuel	1322	1565	1814	1819	1960	1934	1896	1905	1870
Energy end-use sectors	814	957	1160	1104	1104	1104	1114	1114	1114
Transportation	472	566	682	752	752	752	687	687	687
Gasoline	332	361	388	435	435	435	378	378	378
Diesel	95	127	182	195	195	195	188	188	188
Jet fuel	38	72	105	115	115	115	106	106	106
Other	7	6	6	6	6	6	15	15	15
Commercial	74	87	95	89	89	89	86	86	86
Natural gas	60	73	79	79	79	79	72	72	72
Petroleum	10	9	12	2	2	2	10	10	10
Coal	4	4	4	8	8	8	3	3	3
Industrial	132	143	207	116	116	116	181	181	181
Natural gas	53	67	97	71	71	71	87	87	87
Petroleum	49	51	74	40	40	40	66	66	66
Coal	30	25	37	5	5	5	28	28	28
Residential	137	161	175	147	147	147	161	161	161
Natural gas	117	137	148	119	119	119	147	147	147
Petroleum	17	22	25	24	24	24	12	12	12
Coal	2	2	2	4	4	4	2	2	2
Utility Sector	508	608	654	715	856	830	782	790	755
Natural gas	4	5	5	15	15	96	31	31	96
Petroleum	1	1	2	1	1	1	3	3	3
Coal	503	602	648	699	840	733	749	757	657

Part 1, Sections 1 to 3 of this chapter discuss the three different methods for estimating future fossil fuel combustion in the end-use sectors — the Steady State (SS), Continuing Trend (CT) and *Annual Energy Outlook* (AEO) methods.

Part 1, Section 4 compares the projections of energy use resulting from these methods. The SS, CT and AEO projections of total end-use sector primary fossil fuel energy consumption tend to converge; for 2015, they estimate that about 80 to 81 million tons of CO_2 emissions will result from fossil fuel combustion in the four sectors. However, the three methods differ in their projections of how this consumption will be distributed across fuels and sectors.

Part 2 estimates CO_2 emissions in Missouri's end-use sectors from fossil fuel combustion, using the estimates of future fossil fuel use developed in Part 1. The estimates are limited to CO_2 emissions from fossil fuel combustion; estimates of CO_2 emissions from other uses of fossil fuels are treated in Chapter 4. All estimates of CO_2 emissions are given in short tons.

The methodology and data sources used to generate the estimates are identical to those described in the *1990 Inventory* and in Chapter 2 of this study. As in Chapter 2, the analysis assumes an economic growth rate of 1.9 percent and relies on projections of Missouri population supplied by the Missouri state demographer and USDOE/EIA.[2] In using carbon content coefficients from these sources, the analysis assumes that the sources and physical characteristics of the fossil fuel consumed will remain stable between 1997 and 2015.

Part 3 presents seven estimates (scenarios) of total state CO_2 emissions from fossil fuel combustion. Each scenario estimate includes two emissions sources — the end-use sectors, whose emissions are estimated in Part 2, and electric utilities, whose emissions are estimated in Chapter 2. The two sources are aggregated by allocating utility CO_2 emissions to the four end-use sectors, based on each end-use sector's share of total electricity use.

The scenarios are adopted from Chapter 2, which introduced scenarios to accommodate uncertainty surrounding future utility energy use. Chapter 2 defined seven methods for estimating utility emissions — three based on the Continuing Trend method, three based on the AEO method, and the seventh based on the Steady State method. Table 3 summarizes the parameters that define the composite scenarios. They are organized into low-, midrange-, and high-emissions scenarios adopted from Chapter 2.

Table 4 summarizes the projections for 2005 and 2015 that result from applying these methods, showing both utility and end-use emissions as well as the aggregate projection. The low-CO_2 scenarios project that total CO_2 emissions from energy use will increase about 42 to 44 million tons between 1990 and 2015, a 38 to 39 percent increase over 1990 emissions. The midrange scenarios project that total CO_2 emissions from energy use will increase about 50 million tons from 1990 to 2015, a 44 to 47 percent increase over 1990 emissions. In these scenarios, end-use CO_2 emissions (that is, emissions from primary fossil fuel use in the end-use sectors) remain larger than utility emissions through the year 2015.

[2] Sources: Missouri Office of Administration, Division of Budgeting and Planning, *Projections of the Population of Missouri Counties by Age, Gender and Race, 1990 to 2020*, May 1994.

Utility emissions are the primary driver that separates the estimates into low-, midrange and high-CO_2 scenarios. In the low-CO_2 scenarios, end-use CO_2 emissions (that is, emissions from primary fossil fuel use in the end-use sectors) are larger than utility emissions through the year 2015. In the midrange- and high-CO_2 scenarios, end-use CO_2 emissions (that is, emissions from primary fossil fuel use in the end-use sectors) are larger than utility emissions through the year 2015.

Table 3 - Summary of parameters defining the high, midrange and low scenarios for CO_2 emissions from fossil fuel combustion

Scenario	Name of Method	How fossil fuel use and CO_2 emissions are estimated for utility sector	How estimated for end-use sectors
Low	SS direct estimate	SS direct estimate (assume that fuel use remains constant per capita or per GSP)	SS direct estimate
	AEO sales – HighNG	Estimate electricity sales based on AEO; estimate coal use based on model	AOE direct estimate
	CT direct estimate	CT direct estimate (linear regression on Missouri utility fuel use trends)	CT direct estimate
Midrange	AEO direct estimate	AEO direct estimate (based on AEO regional projection of utility fuel use)	AEO direct estimate
	AEO sales – LowNG	Estimate electricity sales based on AEO; estimate coal use based on model	AEO direct estimate
	CT sales – HighNG	Estimate electricity sales based on trend; estimate coal use based on model	CT direct estimate
High	CT sales – LowNG	Estimate electricity sales based on trend; estimate coal use based on model	CT direct estimate

Table 4 - Historic and projected Missouri CO_2 emissions from fossil fuel combustion, by scenario, 1990, 1996, 2005 and 2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	Scenario	Method	Projected CO_2 emissions			Percent change	
			Utility CO_2 emissions	End-use CO_2 emissions	Total CO_2 emissions	Since 1990	Since 1996
1990			51,539	59,934	111,472		
1996			63,288	70,123	133,411	20%	n/a
2005	**Low**	SS direct estimate	65,910	76,636	142,546	28%	7%
		AEO Sales-HighNG	69,972	76,522	146,494	31%	10%
		CT direct estimate	65,413	73,561	138,974	25%	4%
	Midrange	AEO direct estimate	73,158	76,522	149,681	34%	12%
		AEO Sales-LowNG	71,110	76,522	147,632	32%	11%
		CT Sales-HighNG	72,459	73,561	146,019	31%	9%
	High	CT Sales-LowNG	73,660	73,561	147,221	32%	10%
2015	**Low**	SS direct estimate	68,516	85,050	153,566	38%	15%
		AEO Sales-HighNG	74,224	80,356	154,580	39%	16%
		CT direct estimate	73,893	81,209	155,102	39%	16%
	Midrange	AEO direct estimate	80,467	80,356	160,822	44%	21%
		AEO Sales-LowNG	80,877	80,356	161,233	45%	21%
		CT Sales-HighNG	82,131	81,209	163,339	47%	22%
	High	CT Sales-LowNG	88,621	81,209	169,830	52%	27%

Table 5 summarizes aggregate emissions, by scenario, for 1990, 1996, 2000 and subsequent five-year intervals through 2015. Table 5 also summarizes each interval's average annual growth rate and increase over 1990 emissions. A comparison of the growth rate for a given period to previous and subsequent periods can indicate whether the increase in CO_2 emissions is accelerating or decelerating. These comparisons show that for most scenarios and periods the rate of CO_2 emissions growth is projected to decline.

Table 6, Table 7 and Table 8 summarize the percentage changes and growth rates of the sectors' CO_2 emissions in 2015 compared to 1990. CO_2 emissions from fossil fuel combustion constituted about 75 percent of total greenhouse gas (GHG) source emissions in 1990, but, as Table 6 indicates, the share of Missouri CO_2 emissions deriving from energy use will probably grow to about 83 to 84 percent by 2015.

The average growth rates for energy-based CO_2 emissions that appear in Table 8 are higher than those in Table 5 because they are based on growth since 1990 and therefore include the rapid growth in CO_2 emissions that occurred between 1990 and 1996. The effect of including the 1990 to 1996 period can also be seen by comparing the two rightmost columns in Table 4, one giving average growth rates since 1990 and the other average growth rates since 1996.

Table 9 and Table 10 present four-sector summaries of total state GHG emissions estimates, including a breakdown for each end-use sector into CO_2 emissions from primary fuel use and allocated from utilities. For GHG sources and sinks other than CO_2 emissions from fossil fuel combustion, each of the scenarios in Tables 9 and 10 uses the same estimate.

Table 5 - Projected CO_2 emissions from fossil fuel combustion in Missouri, by scenario, 1990-2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

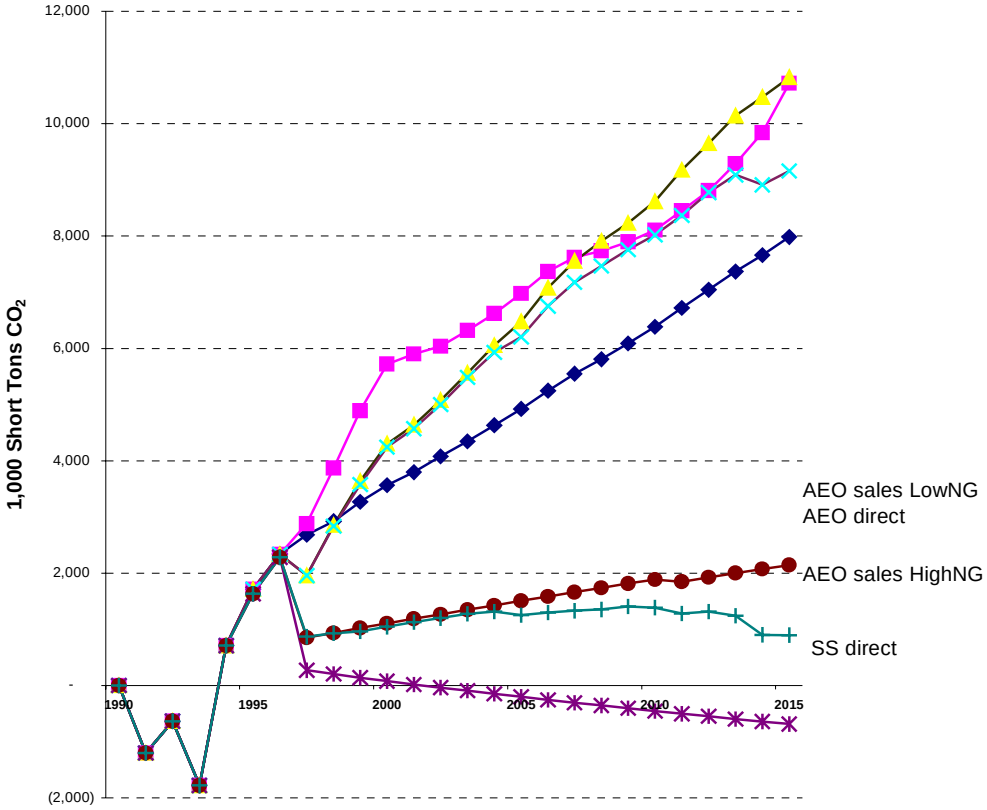

Table 6 - Summary of Missouri greenhouse gas emissions, by scenario, 1990, 1996 and 2015

Units: 1,000 Short Tons Carbon Dioxide Equivalent (STCDE)

	1990	1996	CT direct estimate	CT Sales-LowNG	CT Sales-HighNG	AEO direct estimate	AEO Sales-LowNG	AEO Sales-HighNG	SS direct estimate
Net greenhouse gas emissions	120,996	141,893	165,945	180,672	174,182	171,503	171,914	165,261	164,352
Fossil fuel CO_2 including electricity	111,472	133,411	155,102	169,830	163,339	160,822	161,233	154,580	153,566
Transportation	36,782	44,208	58,842	58,842	58,842	52,250	52,250	52,250	53,303
Commercial	23,104	29,089	36,275	42,391	39,696	34,408	34,556	32,153	32,208
Industrial	22,649	24,927	21,962	24,794	23,546	33,371	33,474	31,807	30,630
Residential	28,937	35,187	38,023	43,803	41,255	40,793	40,952	38,370	37,425
Other sources	36,598	34,215	33,345	33,345	33,345	33,183	33,183	33,183	33,288
Fossil energy as % of source	75%	80%	82%	84%	83%	83%	83%	82%	82%

Table 7 - Percent increase of Missouri greenhouse gas emissions, by scenario, 1996 and 2015 compared to 1990

	1990	1996	CT direct estimate	CT Sales-LowNG	CT Sales-HighNG	AEO direct estimate	AEO Sales-LowNG	AEO Sales-HighNG	SS direct estimate
Net greenhouse gas emissions		17%	37%	49%	44%	42%	42%	37%	36%
Fossil fuel CO_2 including electricity		20%	39%	52%	47%	44%	45%	39%	38%
Transportation		20%	60%	60%	60%	42%	42%	42%	45%
Commercial		26%	57%	83%	72%	49%	50%	39%	39%
Industrial		10%	-3%	9%	4%	47%	48%	40%	35%
Residential		22%	31%	51%	43%	41%	42%	33%	29%
Other sources		-7%	-9%	-9%	-9%	-9%	-9%	-9%	-9%

Table 8 - Rate of growth of Missouri greenhouse gas emissions, by scenario, 1996 and 2015 compared to 1990

	1990	1996	CT direct estimate	CT Sales-LowNG	CT Sales-HighNG	AEO direct estimate	AEO Sales-LowNG	AEO Sales-HighNG	SS direct estimate
Net greenhouse gas emissions		2.7%	1.3%	1.6%	1.5%	1.4%	1.4%	1.3%	1.2%
Fossil fuel CO_2 including electricity		3.0%	1.3%	1.7%	1.5%	1.5%	1.5%	1.3%	1.3%
Transportation		3.1%	1.9%	1.9%	1.9%	1.4%	1.4%	1.4%	1.5%
Commercial		3.9%	1.8%	2.5%	2.2%	1.6%	1.6%	1.3%	1.3%
Industrial		1.6%	-0.1%	0.4%	0.2%	1.6%	1.6%	1.4%	1.2%
Residential		3.3%	1.1%	1.7%	1.4%	1.4%	1.4%	1.1%	1.0%
Other sources		-1.1%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%

Table 9 - Summary projections of Missouri greenhouse gas emissions, by scenario, 2005

Units: 1,000 Short Tons Carbon Dioxide Equivalent (STCDE)

	1990	1996	CT direct estimate	CT Sales-LowNG	CT Sales-HighNG	AEO direct estimate	AEO Sales-LowNG	AEO Sales-HighNG	SS direct estimate
Net greenhouse gas emissions	120,996	141,893	147,228	155,474	154,273	157,932	155,884	154,746	150,783
Greenhouse gas sources	148,071	167,626	171,368	179,614	178,413	182,073	180,024	178,886	174,924
Carbon dioxide emissions	123,129	145,289	151,578	159,824	158,623	162,282	160,234	159,096	155,133
CO_2 from fossil fuel combustion	111,472	133,411	138,974	147,221	146,019	149,681	147,632	146,494	142,546
Transportation	36,782	44,208	50,326	50,326	50,326	49,821	49,821	49,821	48,183
Gasoline	25,826	28,044	30,646	30,646	30,646	29,305	29,305	29,305	29,037
Diesel	7,578	10,131	12,421	12,421	12,421	12,461	12,461	12,461	12,035
Jet	2,971	5,672	6,897	6,897	6,897	7,398	7,398	7,398	6,738
Other	408	360	362	362	362	658	658	658	373
Commercial	23,104	29,089	31,282	34,554	34,078	32,055	31,306	30,891	30,587
Electricity	18,479	23,625	25,956	29,228	28,751	26,733	25,984	25,568	24,925
Nat. Gas	3,494	4,258	4,251	4,251	4,251	4,179	4,179	4,179	4,409
Petroleum	721	881	438	438	438	810	810	810	906
Coal	410	325	637	637	637	334	334	334	346
Industrial	22,649	24,927	22,444	24,153	23,904	29,626	29,129	28,853	27,570
Electricity	12,365	14,314	13,553	15,262	15,013	17,754	17,256	16,980	14,906
Nat. Gas	3,077	3,921	3,838	3,838	3,838	4,623	4,623	4,623	4,658
Petroleum	4,107	4,127	3,474	3,474	3,474	4,594	4,594	4,594	4,903
Coal	3,100	2,564	1,579	1,579	1,579	2,655	2,655	2,655	3,104
Residential	28,937	35,187	34,921	38,187	37,711	38,178	37,376	36,930	36,206
Electricity	20,694	25,349	25,904	29,170	28,694	28,672	27,870	27,424	26,079
Nat. Gas	6,822	7,986	7,108	7,108	7,108	8,225	8,225	8,225	8,269
Petroleum	1,200	1,680	1,565	1,565	1,565	1,099	1,099	1,099	1,672
Coal	221	173	344	344	344	182	182	182	187
Other sources of CO_2	11,656	11,878	12,604	12,604	12,604	12,602	12,602	12,602	12,588
Methane emissions	16,527	17,876	15,460	15,460	15,460	15,460	15,460	15,460	15,460
Nitrous oxide emissions	3,805	3,820	3,872	3,872	3,872	3,872	3,872	3,872	3,872
PFC emissions	4,611	641	458	458	458	458	458	458	458
CO_2 sequestration from forest growth	(27,074)	(25,732)	(24,140)	(24,140)	(24,140)	(24,140)	(24,140)	(24,140)	(24,140)

Table 10 - Summary projections of Missouri greenhouse gas emissions, by scenario, 2015

Units: 1,000 Short Tons Carbon Dioxide Equivalent (STCDE)

	1990	1996	CT direct estimate	CT Sales-LowNG	CT Sales-HighNG	AEO direct estimate	AEO Sales-LowNG	AEO Sales-HighNG	SS direct estimate
Net greenhouse gas emissions	120,996	141,893	165,945	180,672	174,182	171,503	171,914	165,261	164,352
Greenhouse gas sources	148,071	167,626	188,448	203,175	196,685	194,006	194,416	187,763	186,854
Carbon dioxide emissions	123,129	145,289	168,575	183,302	176,812	174,133	174,543	167,890	166,981
CO_2 from fossil fuel combustion	111,472	133,411	155,102	169,830	163,339	160,822	161,233	154,580	153,566
Transportation	36,782	44,208	58,842	58,842	58,842	52,250	52,250	52,250	53,303
Gasoline	25,826	28,044	33,831	33,831	33,831	29,332	29,332	29,332	30,186
Diesel	7,578	10,131	15,595	15,595	15,595	13,612	13,612	13,612	14,572
Jet	2,971	5,672	9,052	9,052	9,052	8,398	8,398	8,398	8,158
Other	408	360	365	365	365	908	908	908	388
Commercial	23,104	29,089	36,275	42,391	39,696	34,408	34,556	32,153	32,208
Electricity	18,479	23,625	30,685	36,801	34,106	29,067	29,215	26,812	26,322
Nat. Gas	3,494	4,258	4,620	4,620	4,620	4,214	4,214	4,214	4,583
Petroleum	721	881	127	127	127	784	784	784	942
Coal	410	325	843	843	843	343	343	343	360
Industrial	22,649	24,927	21,962	24,794	23,546	33,371	33,474	31,807	30,630
Electricity	12,365	14,314	14,208	17,040	15,792	20,170	20,273	18,605	15,297
Nat. Gas	3,077	3,921	4,103	4,103	4,103	5,091	5,091	5,091	5,640
Petroleum	4,107	4,127	3,118	3,118	3,118	5,272	5,272	5,272	5,936
Coal	3,100	2,564	533	533	533	2,839	2,839	2,839	3,758
Residential	28,937	35,187	38,023	43,803	41,255	40,793	40,952	38,370	37,425
Electricity	20,694	25,349	29,000	34,780	32,233	31,230	31,389	28,807	26,897
Nat. Gas	6,822	7,986	6,927	6,927	6,927	8,558	8,558	8,558	8,596
Petroleum	1,200	1,680	1,640	1,640	1,640	814	814	814	1,738
Coal	221	173	455	455	455	191	191	191	194
Other sources of CO_2	11,656	11,878	13,472	13,472	13,472	13,310	13,310	13,310	13,415
Methane emissions	16,527	17,876	15,589	15,589	15,589	15,589	15,589	15,589	15,589
Nitrous oxide emissions	3,805	3,820	3,868	3,868	3,868	3,868	3,868	3,868	3,868
PFC emissions	4,611	641	416	416	416	416	416	416	416
CO_2 sequestration from forest growth	(27,074)	(25,732)	(22,503)	(22,503)	(22,503)	(22,503)	(22,503)	(22,503)	(22,503)

Part 1: Estimates of future fossil fuel combustion in Missouri's transportation, residential, commercial and industrial sectors

Sections 1 through 3 describe three methods for projecting fossil fuel use in Missouri end-use sectors — the transportation, residential, industrial and commercial sectors. Section 4 compares the differences in the scenarios' projections for different fuels and sectors. Section 5 estimates emissions for each fuel in each sector, aggregates these estimates by sector and extends the utility emissions scenario analysis developed in Chapter 4 to include end-use sector emissions.

The three methods, introduced in Chapter 2, are as follows:

- the Steady State (SS) scenario, which assumes that use of Missouri fossil fuel per person or per unit of Gross State Product (GSP) will remain constant from 1996 through 2015;

- the Continuing Trend (CT) scenario, which assumes that Missouri fossil fuel use will continue to increase or decrease between 1996 and 2015 as it has in the recent past; and

- the AEO scenario, which assumes that changes in Missouri's fossil fuel use will mirror those that are projected nationally or regionally by the USDOE Energy Information Administration (EIA) in its *Annual Energy Outlook 1997.*

Section 1: Steady State method

The Steady State (SS) method estimates future fossil fuel use *assuming that current patterns of energy use continue into the future*. The method assumes that, through the year 2015, Missouri citizens and businesses will continue to use energy resources as they do now. More specifically, projections of energy use under the steady state method assume that fuel use per capita or per unit of gross state product (GSP) will remain constant at 1996 levels through 2015.

In the simple form in which it is developed here, the only energy data used by the SS method for its projections are current (1996) consumption numbers. Thus, the projection incorporates no information about past changes in energy use. It also does not project the impact of factors such as changes in economic activity or structure, demographic shifts, technological change or the development or exhaustion of energy resources. Because the SS method does not incorporate such factors, its value is primarily to provide perspective for interpreting other methods rather than for stand-alone projection of state energy use.

The primary assumptions of the SS method are as follows:

- For the industrial sector and for certain transportation fuels (diesel and jet fuel), fuel use per unit of GSP will remain constant at 1996 levels through 2015. Thus, future consumption of these fuels is assumed to grow at the projected growth rate of GSP.[3] Missouri GSP is expected to grow at a rate of about 1.9 percent through 2015.

- For other transportation fuels and other sectors, fuel use per capita will remain constant at 1996 levels through 2015. Thus, future consumption is assumed to grow at the projected growth rate of state population. Missouri population is expected to grow at a rate of about 0.4 percent through 2015.[4]

The assumption that utility fuel use will increase at the rate of population growth implies slower growth in utility fossil fuel use compared to the growth that occurred between 1990 and 1996 or compared to the average growth of all fuel consumption. Utility fossil fuel use increased by 21 percent between 1990 and 1996, a six-year span. According to the SS method projection, by 2015 utility fossil fuel use will increase to only 30 percent of 1990 usage, while total fossil fuel use in 2015 by all Missouri sectors will be about 38 percent greater than in 1990.

Table 11 summarizes the assumptions used to project fossil fuel combustion in the different sectors.

Table 11 - Steady State method to project end-use sector fossil fuel combustion

Sector	Item Projected	Assumptions
Residential and commercial	All fossil fuel use	Constant energy use per capita
Industrial	All fossil fuel use	Constant energy use per unit of GSP
Transportation	Use of diesel and jet fuel	Grows at projected growth rate of Missouri GSP
Transportation	Use of gasoline and other fuels	Grows at projected growth rate of Missouri Population

Table 12 summarizes the SS method's projections of fossil fuel combustion by sector, and the three subsequent tables summarize the method's projections for use of coal, petroleum and natural gas. Under the SS method, fossil fuel energy use is projected to increase from about 1.32 trillion Btus in 1990 to about 1.82 trillion Btus in 2015.

[3] Estimate by Business and Public Administration Research Center, University of Missouri - Columbia.

[4] Projections of Missouri population developed by the Missouri state demographer are used throughout the study. The zero migration model was used, and population estimates were adjusted using an "adder," which adjusted projected state population to actual population in 1995.

Table 12 - Steady State method projections of fossil fuel combustion in Missouri

Units: Trillion Btus

	1990	1996	2005	2010	2015	Change from base
Fossil fuel combustion	1,321.7	1,568.6	1,683.2	1,748.2	1,814.0	37%
Energy end-use sectors	814.1	960.6	1,053.6	1,106.3	1,159.5	42%
Transportation	471.5	565.5	622.9	653.4	682.5	45%
Gasoline	332.4	360.9	373.7	381.0	388.5	17%
Diesel	94.9	126.9	150.7	165.8	182.5	92%
Jet fuel	37.6	71.8	92.4	100.4	105.2	179%
Other	6.6	5.9	6.1	6.2	6.4	-4%
Commercial	73.6	88.0	91.1	92.9	94.7	29%
Natural gas	60.0	73.2	75.8	77.2	78.8	31%
Petroleum	9.5	11.6	11.9	12.2	12.4	31%
Coal	4.0	3.2	3.4	3.5	3.5	-13%
Industrial	132.2	143.8	171.3	188.5	207.5	57%
Natural gas	52.9	67.4	80.0	88.1	96.9	83%
Petroleum	48.9	51.3	60.9	67.0	73.7	51%
Coal	30.4	25.1	30.4	33.4	36.8	21%
Residential	136.8	163.3	168.2	171.5	174.9	28%
Natural gas	117.2	137.2	142.1	144.8	147.7	26%
Petroleum	17.4	24.4	24.3	24.8	25.3	45%
Coal	2.2	1.7	1.8	1.9	1.9	-12%
Electric utility sector	507.6	608.1	629.6	641.9	654.5	29%
Natural gas	3.6	4.9	5.1	5.2	5.3	48%
Petroleum	1.2	1.4	1.5	1.5	1.6	34%
Coal	502.9	601.7	623.0	635.2	647.7	29%

Table 13 - Coal combustion under the Steady State method, showing each sector's share of coal use

Units: Trillion Btus

	1990	1996	2005	2010	2015
Commercial	4	3	3	3	4
Industrial	30	25	30	33	37
Residential	2	2	2	2	2
Utility	503	602	623	635	648
Total coal use	539	632	659	674	690
Total for end-use sectors	***37***	***30***	***36***	***39***	***42***
Increase over 1990					
Commercial		-21.1%	-15.9%	-14.3%	-12.6%
Industrial		-17.3%	0.1%	10.1%	21.2%
Residential		-22.0%	-15.8%	-14.1%	-12.4%
Utility		19.7%	23.9%	26.3%	28.8%
End-use sectors		***-18.0%***	***-2.6%***	***6.0%***	***15.4%***

Table 14 - Petroleum combustion under the Steady State method, showing each sector's share of petroleum use

Units: Trillion Btus

	1990	1996	2005	2010	2015
Transportation	466	561	618	648	677
Gasoline	332	361	374	381	388
Diesel	95	127	151	166	182
Jet fuel	38	72	92	100	105
Other	1	1	1	1	1
Commercial	10	12	12	12	12
Industrial	49	51	61	67	74
Residential	17	24	24	25	25
Utility	1	1	1	2	2
Total petroleum use	543	649	717	754	790
End-use sectors	***542***	***648***	***715***	***752***	***789***
Increase over 1990					
Transportation		20.3%	32.6%	39.1%	45.3%
Gasoline		8.6%	12.4%	14.6%	16.9%
Diesel		33.7%	58.8%	74.8%	92.3%
Jet fuel		90.9%	145.6%	166.7%	179.5%
Other		-14.3%	-11.2%	-9.5%	-7.7%
Commercial		22.3%	25.8%	28.2%	30.7%
Industrial		4.8%	24.5%	37.0%	50.8%
Residential		40.0%	39.4%	42.1%	44.9%
Utility		24.1%	28.5%	31.0%	33.6%
End-use sectors		***19.6%***	***31.9%***	***38.8%***	***45.5%***

Table 15 - Natural gas combustion under the Steady State method, showing each sector's share of natural gas use

Units: Trillion Btus

	1990	1996	2005	2010	2015
Transportation	5	5	5	5	5
Commercial	60	73	76	77	79
Industrial	53	67	80	88	97
Residential	117	137	142	145	148
Utility	4	5	5	5	5
Total natural gas use	239	287	308	320	334
End-use sectors	***235***	***283***	***303***	***315***	***329***

Increase over 1990	**1990**	**1996**	**2005**	**2010**	**2015**
Transportation		-10.4%	-7.2%	-5.4%	-3.5%
Commercial		21.9%	26.2%	28.7%	31.2%
Industrial		27.4%	51.4%	66.6%	83.3%
Residential		17.1%	21.2%	23.6%	26.0%
Utility		37.1%	42.0%	44.7%	47.6%
End-use sectors		***20.0%***	***28.6%***	***33.9%***	***39.5%***

Section 2: Continuing Trend method

The Continuing Trend (CT) method estimates CO_2 emissions from fossil fuel *assuming that recent trends in Missouri's energy use continue into the future*. This method relies on projecting future energy use from past energy consumption data. Thus the CT method's projections make use of more energy data than those of the SS method and implicitly incorporate the past influence of economic, demographic and technological factors. However, the CT method does not incorporate information about how these factors might change in the future. Implicitly, it assumes that future energy use will be determined by the same factors that have determined past energy use.

The CT method uses simple linear regression to project past energy use trends into the future.[5] For the end-use sectors, the regression analysis was based on trends from 1982 to the most recent data available. Although data previous to 1982 was available, it was not incorporated into the regression analysis because from 1974 to 1982 there were unique disturbances to energy supply and demand. Use of data from these years would probably have distorted the results of the trend analysis. Chapter 2 describes the CT methods used for the utility sector projections.

Table 16 summarizes the CT method's projections of fossil fuel combustion by sector, and the three subsequent tables summarize the method's projections for use of coal, petroleum and natural gas. Fossil fuel energy use is projected to increase from about 1.32 trillion Btus in 1990 to about 1.82 trillion Btus in 2015.

[5] ORIMA methods would have been more suitable but the statistical tools were not available for this project. One consequence of using regression is that, in many cases the dependent value for 1996 emissions estimated by least-square regression is less than the historic value, whereas the SS and AEO estimates assume the historic value for 1996 emissions as a beginning point. Therefore, although the CT projection captures a great deal of information from previous years, it is probably more meaningful for intermediate than short-term projections.

Table 16 - Continuing Trend method projections of fossil fuel combustion in Missouri

Units: Trillion Btus

	1990	1995	2005	2010	2015	Change from base
Fossil fuel use	1,322	1,497	1,634	1,726	1,819	38%
Energy end-use sectors	814	914	1,002	1,052	1,104	36%
Transportation	472	542	643	697	752	59%
Gasoline - tran	332	352	394	414	435	31%
Diesel - tran	95	118	156	175	195	106%
Jet fuel - tran	38	66	87	101	115	205%
Other transportation fuels	7	6	6	6	6	-6%
Commercial	74	80	85	87	89	21%
Nat. gas - comm	60	65	73	76	79	32%
Petroleum - comm	10	11	6	4	2	-82%
Coal - comm	4	3	6	7	8	104%
Industrial	132	142	125	120	116	-12%
Nat. gas - indust	53	66	66	68	71	33%
Petroleum - indust	49	50	44	42	40	-18%
Coal - indust	30	25	15	10	5	-83%
Residential	137	150	148	148	147	8%
Nat. gas - res	117	125	122	121	119	2%
Petroleum - res	17	23	23	23	24	37%
Coal - res	2	2	3	4	4	105%
Electric utility sector	508	583	632	673	715	41%
Nat. gas - utility	4	13	11	13	15	314%
Petroleum- utility	1	2	1	1	1	-21%
Coal - utility	503	569	620	660	699	39%

Table 17 - Coal combustion under the Continuing Trend method, showing each sector's share of coal use

Units: Trillion Btus

	1990	1995	2005	2010	2015
Commercial	4	3	6	7	8
Industrial	30	25	15	10	5
Residential	2	2	3	4	4
Utility	503	569	620	660	699
Total coal use	539	599	645	681	717
Total for end-use sectors	***37***	***30***	***25***	***22***	***18***
Increase over 1990					
Commercial		-19.3%	54.7%	79.6%	104.5%
Industrial		-16.5%	-49.1%	-66.0%	-82.8%
Residential		-18.7%	55.1%	80.1%	105.0%
Utility		13.1%	23.3%	31.2%	39.0%
End use sectors		***11.1%***	***19.6%***	***26.3%***	***32.9%***

Table 18 - Petroleum combustion under the Continuing Trend method, showing each sector's share of petroleum use

Units: Trillion Btus

	1990	1995	2005	2010	2015
Transportation	466	537	638	691	746
Gasoline	332	352	394	414	435
Diesel	95	118	156	175	195
Jet fuel	38	66	87	101	115
Other	1	1	1	1	0
Commercial	10	11	6	4	2
Industrial	49	50	44	42	40
Residential	17	23	23	23	24
Utility	1	2	1	1	1
Total petroleum use	543	624	711	761	812
End-use sectors	***542***	***622***	***710***	***760***	***811***
Increase over 1990					
Transportation		15.2%	36.9%	48.3%	60.0%
Gasoline		6.0%	18.7%	24.7%	31.0%
Diesel		24.4%	63.9%	84.9%	105.8%
Jet fuel		75.2%	132.2%	168.4%	204.7%
Other		-11.3%	-40.8%	-55.5%	-70.2%
Commercial		20.8%	-39.2%	-60.8%	-82.3%
Industrial		2.5%	-10.8%	-14.4%	-17.9%
Residential		34.4%	30.5%	33.6%	36.8%
Utility		47.6%	2.4%	-9.5%	-21.5%
End-use sectors		***14.8%***	***31.0%***	***40.3%***	***49.7%***

Table 19 - Natural gas combustion under the Continuing Trend method, showing each sector's share of natural gas use

Units: Trillion Btus

	1990	1995	2005	2010	2015
Transportation	5	5	5	6	6
Commercial	60	65	73	76	79
Industrial	53	66	66	68	71
Residential	117	125	122	121	119
Utility	4	13	11	13	15
Total natural gas use	239	274	277	283	290
End-use sectors	***235***	***261***	***266***	***271***	***275***

Increase over 1990	**1990**	**1996**	**2005**	**2010**	**2015**
Transportation		-11.4%	-1.1%	4.1%	9.2%
Commercial		8.4%	21.7%	26.9%	32.2%
Industrial		25.6%	24.7%	29.0%	33.3%
Residential		6.7%	4.2%	2.9%	1.5%
Utility		258.2%	199.3%	256.5%	313.7%

Section 3: Annual Energy Outlook method

The AEO method assumes Missouri's future energy consumption will mirror the energy use projections contained in the USDOE Energy Information Administration's *Annual Energy Outlook 1997*. The *Annual Energy Outlook*, published each year, is based on EIA's National Energy Modeling System (NEMS). NEMS provides national and regional-level business-as-usual estimates of energy use that explicitly incorporate assumptions about future economic, demographic and technological change. The AEO method, unlike the CT method, incorporates information about how these factors might change in the future.

Because NEMS generates only national and regional energy projections, it is necessary to extrapolate state-level projections for Missouri. For most sectors and fuels, the extrapolation is based on AEO projections of per-capita energy use in a two-region area, the North West Central and North East Central regions.[6] For fossil fuels in the industrial sector and certain fuels in the transportation sector that are primarily freight-oriented, the extrapolation is based on AEO projections of national energy use per unit of Gross National Product (GNP).[7]

For each sector and fuel, the following method was used to extrapolate annual projections of energy use:

1. Estimated energy consumption per capita is calculated from EIA regional energy use projections, or estimated energy consumption per unit of GNP is calculated from national energy use projections, depending on the sector and fuel. For example, population was used to extrapolate energy use in the residential and commercial sectors, and gross product was used to extrapolate energy use in the industrial sector.

2. A theoretical estimate of state energy consumption was calculated by multiplying regional energy consumption per capita by the projected state population or by multiplying national energy consumption per unit of GNP by the projected state GSP.

3. An "adder" was calculated to adjust the initial estimate in the series to equal the best estimate of Missouri energy consumption in that year. The same adder was then used to adjust subsequent state energy consumption estimates.

Unlike the SS and CT methods, the AEO method can generate non-linear projections of future energy use based on assumptions about changes in the factors that affect energy use. For example, the curvilinear path of AEO gasoline use projections depicted in Chart 1, on page 37, are curved rather than linear.

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[6] Missouri is included in the North West Central Region and borders the North East Central region. Missouri borders two additional regions, the West South Central and East South Central. The study uses a 2-region instead of a 4-region average because the two southern regions are energy-producing regions and therefore dissimilar to Missouri.

[7] An extrapolation based on energy use per unit of regional gross product could not be used because no data series for regional gross product is available.

The AEO projections incorporate the projections of expected advances in end use technologies including shell and equipment efficiencies. The projections are gathered from industry experts including utilities and manufacturers.

Table 20 summarizes the AEO method's projections of fossil fuel combustion by sector, and the three subsequent tables summarize the method's projections for use of coal, petroleum and natural gas. Fossil fuel energy use is projected to increase from about 1.32 trillion Btus in 1990 to about 1.86 trillion Btus in 2015.

Table 20 - *Annual Energy Outlook* method projections of fossil fuel combustion in Missouri

Units: Trillion Btus

	1990	1996	2005	2010	2015	Change from base
Fossil fuel use	1,321.7	1,568.6	1,778.5	1,835.9	1,961.6	48%
Energy end-use sectors	814.1	960.6	1,054.4	1,091.2	1,114.3	37%
Transportation	471.5	565.5	647.1	674.2	686.5	46%
Gasoline - tran	332.4	360.9	377.2	379.8	377.5	14%
Diesel - tran	94.9	126.9	165.5	179.4	187.9	98%
Jet fuel - tran	37.6	71.8	93.7	101.6	106.4	183%
Other transportation fuels	6.6	5.9	10.7	13.3	14.8	122%
Commercial	73.6	88.0	85.8	85.9	86.1	17%
Nat. gas - comm	60.0	73.2	71.8	72.0	72.4	21%
Petroleum - comm	9.5	11.6	10.7	10.5	10.3	9%
Coal - comm	4.0	3.2	3.3	3.3	3.4	-17%
Industrial	132.2	143.8	162.4	171.5	180.9	37%
Nat. gas - indust	52.9	67.4	79.4	84.2	87.5	65%
Petroleum - indust	48.9	51.3	57.0	60.8	65.7	34%
Coal - indust	30.4	25.1	26.0	26.5	27.8	-8%
Residential	136.8	163.3	159.1	159.6	160.7	17%
Nat. gas - res	117.2	137.2	141.3	144.2	147.0	25%
Petroleum - res	17.4	24.4	16.0	13.6	11.8	-32%
Coal - res	2.2	1.7	1.8	1.8	1.9	-14%
Electric utility sector	507.6	608.1	724.1	744.7	847.3	67%
Nat. gas - utility	3.6	4.9	34.3	50.4	96.0	2581%
Petroleum- utility	1.2	1.4	0.7	1.6	2.6	125%
Coal - utility	502.9	601.7	689.2	692.7	748.6	49%

The following three tables summarize AEO projections of coal, petroleum and natural gas combustion in Missouri through 2015.

Table 21 - Coal combustion under the *Annual Energy Outlook* method, showing each sector's share of coal use

Units: Trillion Btus

	1990	1996	2005	2010	2015
Commercial	4	3	3	3	3
Industrial	30	25	26	27	28
Residential	2	2	2	2	2
Utility	503	602	689	693	749
Total coal use	539	632	720	724	782
Total for end-use sectors	37	30	31	32	33
Increase over 1990					
Commercial		-21.1%	-19.0%	-17.8%	-16.7%
Industrial		-17.3%	-14.4%	-12.7%	-8.5%
Residential		-22.0%	-18.1%	-15.9%	-13.8%
Utility		19.7%	37.0%	37.8%	48.9%
End-use sectors		***17.1%***	***33.5%***	***34.3%***	***44.9%***

Table 22 - Petroleum combustion under the *Annual Energy Outlook* method, showing each sector's share of petroleum use

Units: Trillion Btus

	1990	1995	2005	2010	2015
Transportation	466	561	639	665	676
Gasoline	332	361	377	380	378
Diesel	95	127	165	179	188
Jet fuel	38	72	94	102	106
Other	1	1	3	4	4
Commercial	10	12	11	11	10
Industrial	49	51	57	61	66
Residential	17	24	16	14	12
Utility	1	1	1	2	3
Total petroleum use	543	650	723	751	766
End-use sectors	***542***	***648***	***723***	***750***	***764***
Increase over 1990					
Transportation		20.3%	37.1%	42.6%	45.0%
Gasoline		8.6%	13.5%	14.3%	13.6%
Diesel		33.7%	74.4%	89.1%	98.0%
Jet fuel		90.9%	149.0%	170.1%	182.7%
Other		-12.9%	105.1%	190.1%	234.1%
Commercial		22.3%	12.4%	10.7%	8.8%
Industrial		4.8%	16.5%	24.3%	34.2%
Residential		40.0%	-8.4%	-21.8%	-32.1%
Utility		24.1%	-40.7%	35.4%	124.7%
End-use sectors		***19.6%***	***33.3%***	***38.3%***	***40.9%***

Table 23 - Natural gas combustion under the *Annual Energy Outlook* method, showing each sector's share of natural gas use

Units: Trillion Btus

	1990	1995	2005	2010	2015
Transportation	5	5	8	10	10
Commercial	60	73	72	72	72
Industrial	53	67	79	84	87
Residential	117	137	141	144	147
Utility	4	5	34	50	96
Total natural gas use	239	287	335	360	413
End-use sectors	***235***	***283***	***301***	***310***	***317***

Increase over 1990	**1990**	**1996**	**2005**	**2010**	**2015**
Transportation		-11.1%	51.3%	78.9%	95.7%
Commercial		21.9%	19.6%	20.0%	20.6%
Industrial		27.4%	50.2%	59.3%	65.4%
Residential		17.1%	20.6%	23.0%	25.4%
Utility		37.1%	856.9%	1306.3%	2581.2%

Section 4: Comparison of the AEO and CT estimates of future fossil fuel combustion in Missouri end-use sectors

The CT and AEO scenarios project nearly identical increases in total primary fossil fuel use in the end-use sectors between 1990 and 2015. The CT scenarios project a 36 percent increase over 1990 consumption, and the AEO scenarios project a 37 percent increase.[8]

Despite the similarity in the projected total emissions, the CT and AEO scenarios diverge in their projections for specific sectors and fuels. The differences flow from the different methods used to estimate future consumption. Under the CT method, future consumption is determined primarily by the growth trend of the sector or fuel over the previous 10 to 12 years. Under the AEO method, it may be determined by a variety of assumptions about the influence of future economic, demographic and technological factors on energy use.

The most striking divergence between the scenarios occurs in projecting primary fossil fuel use in the transportation and utility sectors. Through 2015, the AEO scenarios project annual growth rates of 1.5 percent for transportation fossil fuel use and 1.3 percent for industrial use. The CT scenarios project a faster 1.9 percent growth rate for consumption of fossil fuels in the transportation sector and a negative 0.5 percent growth rate for consumption in the industrial sector.

Table 24 summarizes the CT and AEO scenarios' projections of average annual growth rates of primary fossil fuel use in the transportation, commercial, industrial and residential sectors between 1990 and 2015.

[8] The SS scenario projects a 42 percent increase, larger than that from the CT and AEO scenarios. However, this section focuses on the CT and AEO scenarios. Under the SS method, the increase in consumption of a specific fuel is determined primarily by whether consumption is assumed to grow at the state population growth rate or the state GSP growth rate. The method is included primarily for comparison; it uses less information than the other two methods, and some of its projections lack credibility.

Table 24 - Average annual growth rates of primary fossil fuel use in the end-use sectors, for the CT and AEO methods, 1990-2015

	CT average annual growth rate				AEO average annual growth rate			
	1990-1996	1996-2005	2005-2015	1990-2015	1990-1996	1996-2005	2005-2015	1990-2015
Transportation	3.1%	1.4%	1.6%	1.9%	3.1%	1.5%	0.6%	1.5%
Gasoline	1.4%	1.0%	1.0%	1.1%	1.4%	0.5%	0.0%	0.5%
Diesel	5.0%	2.3%	2.3%	2.9%	5.0%	3.0%	1.3%	2.8%
Jet fuel	11.4%	2.2%	2.8%	4.6%	11.4%	3.0%	1.3%	4.2%
Other	-1.9%	0.3%	0.3%	-0.3%	-1.9%	6.9%	3.2%	3.2%
Commercial	2.8%	-0.3%	0.5%	0.8%	2.8%	-0.2%	0.0%	0.6%
Natural gas	3.4%	0.0%	0.8%	1.1%	3.4%	-0.2%	0.1%	0.8%
Petroleum	-0.1%	-5.3%	-11.6%	-6.7%	-0.1%	1.4%	-0.3%	0.3%
Coal	1.6%	3.9%	2.8%	2.9%	1.6%	-3.3%	0.3%	-0.7%
Industrial	1.4%	-1.5%	-0.8%	-0.5%	1.4%	1.4%	1.1%	1.3%
Natural gas	4.1%	-0.2%	0.7%	1.2%	4.1%	1.8%	1.0%	2.0%
Petroleum	0.8%	-1.8%	-0.8%	-0.8%	0.8%	1.2%	1.4%	1.2%
Coal	-3.4%	-5.1%	-10.3%	-6.8%	-3.4%	0.6%	0.7%	-0.4%
Residential	2.8%	-0.9%	-0.1%	0.3%	2.8%	-0.2%	0.1%	0.6%
Natural gas	2.7%	-1.3%	-0.3%	0.1%	2.7%	0.3%	0.4%	0.9%
Petroleum	3.8%	0.5%	0.5%	1.3%	3.8%	-3.4%	-3.0%	-1.5%
Coal	1.6%	3.9%	2.8%	2.9%	1.6%	-3.2%	0.5%	-0.6%

Transportation fossil fuel combustion

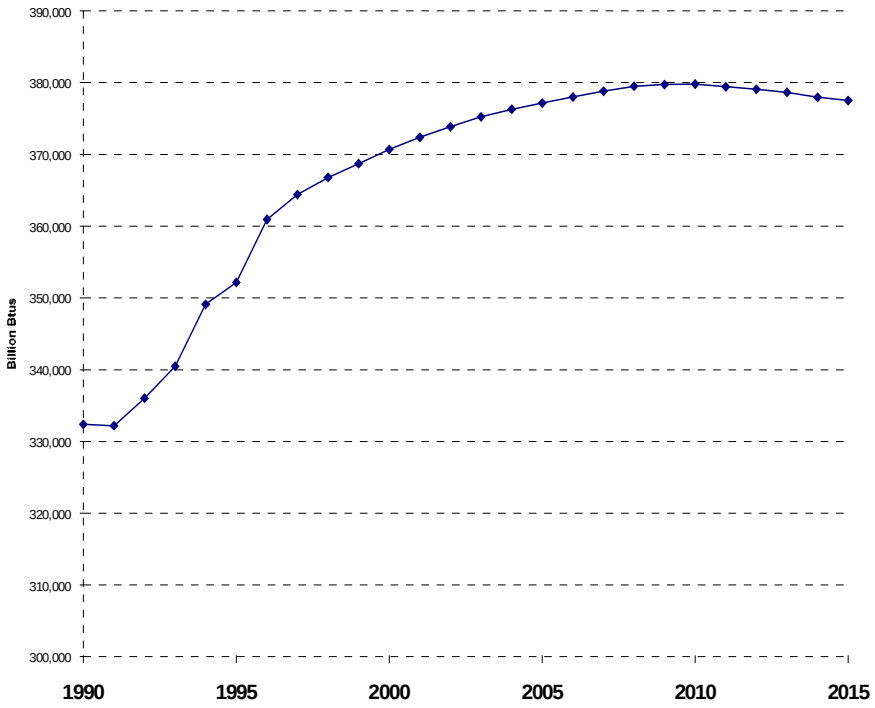
In 1990, use of motor gasoline, primarily for personal vehicles, accounted for about 71 percent of total fossil fuel use in Missouri's transportation sector. The AEO and CT scenarios project that between 1990 and 2015, diesel and jet fuel will become more prominent in the total mix of transportation fuel use.

The CT scenarios anticipate that motor gasoline use will continue to increase at an average annual growth rate of 1 percent. Nevertheless, these scenarios anticipate that gasoline's share will decline to about 58 percent of the total transportation mix because diesel and jet fuel use will increase at a higher growth rate than gasoline use. Diesel fuel's share will increase from about 20 percent to 26 percent, and jet fuel's share will increase from about 8 percent to 15 percent. [9]

The AEO scenarios, which are based on the USDOE/EIA *Annual Energy Outlook 1997*, anticipate that the growth rate of motor gasoline use will decrease after 1996 and that motor gasoline consumption will decline after 2010. Chart 1 illustrates the AEO projection for gasoline use through 2015.

[9] The projections for Missouri jet fuel use are based on simple regression of trend (CT method) or AEO regional projections. They may underestimate the future rate of growth of jet fuel use in Missouri because they do not take into account the planned expansion of Lambert-St. Louis International Airport. Lambert is the sixth busiest commercial airport in the United States. In September, 1998, the Federal Aviation Administration issued a favorable Record of Decision for Lambert's expansion, as described in a press release posted at http://www.lambert-stlouis.com/expansion.html

Chart 1 - Projected gasoline use in Missouri, based on* Annual Energy Outlook 1997 *regional projection, 1990-2015



The AEO scenarios anticipate that gasoline's share will decline to about 55 percent of the total transportation mix. Diesel fuel's share will increase from about 20 percent to 27 percent, and jet fuel's share will nearly double from about 8 percent to 16 percent.

By 2015, transportation fossil fuel use under the CT scenarios is projected to increase to 60 percent over the level in 1990, versus 46 percent under the AEO scenarios. As Table 24 indicates, the AEO and CT scenarios project nearly identical growth in total transportation fuel use between 1996 and 2005, but diverge sharply between 2005 and 2015.

Under the AEO scenarios, gasoline use does not grow between 2005 and 2015, and growth in diesel and jet fuel use slows from a 3.0 percent annual growth rate to a 1.3 percent annual rate. Under the CT scenarios, gasoline use continues to grow at 1 percent per year, diesel use continues to grow at a 2.3 percent annual rates, and the growth rate of jet fuel use increases from 2.3 percent to 2.8 percent by 2015.

USDOE/EIA projections of gasoline use for transportation are based on economic factors such as price and income as well as legislative mandates and a number of demographic, sociological and technological factors. Factors expected to lead to a decrease in the growth rate for gasoline use include:

(1) A decrease in the growth rate for personal income. The *Annual Energy Outlook 1997* (AEO97) projected that personal income would grow at about 1.9 percent per annum compared to rates between 2.5 and 3.0 percent during previous decades.
(2) An increase in the average age of the driving population. National Personal Transportation Survey (NPTS) data indicate that as people grow older, they drive less. Although "Baby Boomers" may drive more after retirement than previous generations, they are still expected to drive less than during their working years.
(3) One factor previously influencing increases in motor gasoline use was the increase in average Vehicle Miles Traveled (VMT) by women as they entered the work force. This will not be as much a factor in the future as the influx of women into the work force slows and as female VMT approaches male VMT.
(4) Continued gains in vehicle efficiency. In assessing efficiency, EIA takes into account new technologies that are on the horizon such as electric hybrid vehicles and direct injection gasoline vehicles, as well as technologies such as fuel cells that are likely to be introduced later. However, gains are expected to continue but to occur at a slower pace than in the 1980s, in part due to increasing popularity of sport utility vehicles, light trucks and high-horsepower vehicles, which are less efficient than sedans or station wagons.
(5) Greater use of alternative fuel vehicles, including vehicles in commercial fleets.

EIA has revised its analysis since *AOE97* was published. EIA projections for transportation gasoline consumption in the *Annual Energy Outlook* for 1998 *(AEO98)* and 1999 (*AEO99)* are higher than the *AEO97* projections used in this study, and EIA no longer projects an absolute decline in gasoline use after 2010. The *AEO97* national reference case projects a 0.8 percent growth rate for motor gasoline use between 1995-2015; the *AEO98* national reference case projects a 1.3 percent growth rate between the same years. The *AEO99* estimate for the growth in gasoline use will be somewhere in the middle. [10]

[10] *AEO97*, Table A-2; *AEO98*, Table A-2; and personal communication, David Chien, EIA, 9/3/98. The *AEO99* analysis has not been completed and this discussion of its findings is therefore subject to revision.

The most important factors in this revision are economic, particularly fuel price, which affects both fuel consumption and decisions on new vehicle purchase. *AEO98* and *AEO99* project lower gasoline prices than *AEO97* and put greater emphasis on the increasing popularity of sport utility vehicles, light trucks and high-horsepower vehicles. In addition, *AEO98* and *AEO99* project higher growth in personal income than *AEO97,* albeit below the personal income growth rate of previous decades.

Industrial fossil fuel combustion

The industrial sector, unlike Missouri's other energy use sectors, uses a nearly even mix of fuels — approximately 40 percent petroleum, 30 percent natural gas and 30 percent coal in 1990. Primary fossil fuel use in the industrial sector increased at a 1.4 percent average annual growth rate between 1990 and 1996; natural gas use grew at a 4.1 percent annual rate, while coal use declined. However, the CT scenarios project that industrial primary fossil fuel use in 2015 will be lower than total use in 1990, that coal and petroleum use will decline below 1990 levels and that natural gas use will be at approximately the same level as in 1996.

The CT projection reflects post-1980 energy use trends in Missouri's industrial sector; coal use has declined sharply, petroleum use has declined moderately[11] and natural gas use has fluctuated.[11]

In contrast, the AEO scenarios project a 34 percent increase in industrial fossil fuel use, with increases in both natural gas and petroleum use. The *Annual Energy Outlook 1997* cites projections for plentiful supply and stable price as factors leading to growth in natural gas consumption. The *Annual Energy Outlook 1997* also cites technological and structural changes that may reduce industrial energy use, but their impact will be primarily on electricity use.

The SS scenarios project an even larger, 69 percent, increase in industrial fossil fuel use. However, this is a somewhat artificial result that follows from the methodological assumption that industrial fuel consumption will grow at the rate of gross state product.

[11] The downward trend in the projection of petroleum use is partly due to a downward adjustment in USDOE/EIA estimates for industrial petroleum use between 1990 and 1991. See Chapter 2, page 28, Methodological Note 1.

Residential and commercial fossil fuel consumption

With respect to CO_2 emissions, the chief role of the residential and commercial sectors is as consumers of electricity. The two sectors also accounted for about 75 percent of Missouri's natural gas consumption in 1990. However, Table 45, illustrates that electricity use in these sectors is a more important contributor to CO_2 emissions than primary fossil fuel use.

Primary fossil fuel consumption in both sectors achieved a rapid average annual growth rate of 2.8 percent between 1990 and 1996 due to growth of natural gas use in both sectors and growth of petroleum use in the residential sector. However, the AEO and CT scenarios agree that there will be minimal growth in primary fossil fuel consumption in the two sectors between 1996 and 2015.

The *Annual Energy Outlook 1997* cites several factors reducing energy use in the commercial sector. In addition to projected slow growth of commercial floor space, the *Annual Energy Outlook* cites areas in which technological improvements are expected, including the efficiency of building shells and of furnaces, boilers and heat pumps fired by natural gas or distillate oil. The *Annual Energy Outlook* anticipates similar technological improvements in the residential sector.

CT scenario projections for total fuel use in the residential and commercial sectors are quite similar to AEO scenario projections. The only point of divergence is over the projected fuel mix in the residential sector.

The *Annual Energy Outlook 1997* projects that residential natural gas use will increase due to declining natural gas prices, larger homes and increased use of natural gas heat pumps — although this increase will be moderated by increased heating efficiency per residential square foot due to building code requirements for new construction. The *Annual Energy Outlook* further projects that CO_2 emissions from petroleum and coal use will decrease as residential energy users switch to natural gas or electricity and projects that the share of natural gas in the residential fossil fuel mix will increase from 86 to 92 percent between 1990 and 2015.

In contrast, the CT scenarios, on the basis of earlier trends, projects continued reduction in natural gas consumption and very modest growth in residential petroleum and coal consumption. Accordingly, the CT scenarios anticipate that the share of natural gas in the residential fossil fuel mix will decrease from 86 to 81 percent between 1990 and 2015.

Mix and distribution of coal, petroleum and natural gas use

In 1990, utilities consumed 93 percent of the ***coal*** used in Missouri, and the industrial sector consumed nearly 6 percent. From 1990 to 1996, utility consumption increased and industry consumption declined so that in 1996 their shares were 95 percent and 4 percent. The AEO and SS methods project that this distribution will remain constant through 2015, but the CT method projects that industrial coal use, continuing past trends, will decline to less than a 1 percent share by 2015.

In 1990, the transportation sector consumed 86 percent of the ***petroleum*** used in Missouri, and about 61 percent of all petroleum consumption was for gasoline. All three methods project that petroleum will continue to be used predominantly for transportation and that gasoline's share of total petroleum use will decrease as the shares of diesel and jet fuel increase. However, the CT and SS methods anticipate a faster transfer of share from gasoline to diesel than does the AEO method.

In 1990, the residential, commercial and industrial sectors consumed 96 percent of the ***natural gas*** used in Missouri; the residential sector alone consumed 49 percent. All CT and AEO scenarios project more even distribution of natural gas use in 2015.

The standard CT scenario projects that the residential share will fall to 41 percent, with a modest increase in the shares of the commercial, industrial and utility sectors. The standard AEO scenario projects that both the residential and commercial sectors will lose shares to the industrial and utility sectors.

The AEO and CT "HighNG" scenarios project a more radical shift in which the utility sector becomes the second most important user of natural gas, accounting for nearly 30 percent of total natural gas consumption in 2015.

The AEO "HighNG" scenario also projects a shift in the total fossil fuel mix, with the share of natural gas increasing from about 18 to 21 percent between 1990 and 2015 and the share of petroleum decreasing from about 41 to 39 percent. The shift is primarily the result of decelerating growth in gasoline use and increasing utility consumption of natural gas.

The following tables summarize primary fossil fuel use projections for Missouri's end-use sectors. Table 25 summarizes the three methods' projections of Missouri fossil fuel combustion through 2015, and Table 26 summarizes percentage changes from consumption in the 1990 baseline year.

Table 25 - Estimated historic (1990, 1996) and projected (2005, 2015) fossil fuel combustion in Missouri, by sector

Units: Trillion Btus

	1990	1996	2005 SS	2005 CT	2005 AOE	2015 SS	2015 CT	2015 AEO
Use (trillion Btus) by sector and fuel	1,322	1,565	1,683	1,634	1,757	1,814	1,819	1,896
Energy end-use sectors	814	957	1,054	1,002	1,054	1,160	1,104	1,114
Transportation	472	566	623	643	647	682	752	687
Gasoline	332	361	374	394	377	388	435	378
Diesel	95	127	151	156	165	182	195	188
Jet fuel	38	72	92	87	94	105	115	106
Other	7	6	6	6	11	6	6	15
Commercial	74	87	91	85	86	95	89	86
Natural gas	60	73	76	73	72	79	79	72
Petroleum	10	9	12	6	11	12	2	10
Coal	4	4	3	6	3	4	8	3
Industrial	132	143	171	125	162	207	116	181
Natural gas	53	67	80	66	79	97	71	87
Petroleum	49	51	61	44	57	74	40	66
Coal	30	25	30	15	26	37	5	28
Residential	137	161	168	148	159	175	147	161
Natural gas	117	137	142	122	141	148	119	147
Petroleum	17	22	24	23	16	25	24	12
Coal	2	2	2	3	2	2	4	2
Electric utility sector	508	608	630	632	703	654	715	782
Use (trillion Btus) by fuel and sector	1,322	1,565	1,683	1,634	1,757	1,814	1,819	1,896
Coal	539	633	659	645	720	690	717	782
Commercial	4	4	3	6	3	4	8	3
Industrial	30	25	30	15	26	37	5	28
Residential	2	2	2	3	2	2	4	2
Utility	503	602	623	620	689	648	699	749
Petroleum	543	645	717	711	723	790	812	766
Transportation	466	561	618	638	639	677	746	676
Commercial	10	9	12	6	11	12	2	10
Industrial	49	51	61	44	57	74	40	66
Residential	17	22	24	23	16	25	24	12
Utility	1	1	1	1	1	2	1	3
Natural Gas	239	287	308	277	314	334	290	348
Transportation	5	5	5	5	8	5	6	10
Commercial	60	73	76	73	72	79	79	72
Industrial	53	67	80	66	79	97	71	87
Residential	117	137	142	122	141	148	119	147
Utility	4	5	5	11	13	5	15	31

Table 26 - Projected percentage change in Missouri fossil fuel combustion, by method, compared to 1990 baseline

	1990	1996	2005 SS	2005 CT	2005 AOE	2015 SS	2015 CT	2015 AEO
Fossil fuel use, by sector and fuel	0.0%	18.4%	27.3%	23.6%	33.0%	37.2%	37.6%	43.5%
Energy end-use sectors	0.0%	17.6%	29.4%	23.0%	29.5%	42.4%	35.6%	36.9%
Transportation	0.0%	19.9%	32.1%	36.4%	37.2%	44.7%	59.4%	45.6%
Gasoline - tran	0.0%	8.6%	12.4%	18.7%	13.5%	16.9%	31.0%	13.6%
Diesel - tran	0.0%	33.7%	58.8%	63.9%	74.4%	92.3%	105.8%	98.0%
Jet fuel - tran	0.0%	90.9%	145.6%	132.2%	149.0%	179.5%	204.7%	182.7%
Other transportation fuels	0.0%	-11.1%	-8.0%	-8.7%	61.7%	-4.4%	-6.1%	122.4%
Commercial	0.0%	18.3%	23.8%	15.6%	16.5%	28.7%	21.4%	17.0%
Nat. gas - comm	0.0%	21.9%	26.2%	21.7%	19.6%	31.2%	32.2%	20.6%
Petroleum - comm	0.0%	-0.4%	25.8%	-39.2%	12.4%	30.7%	-82.3%	8.8%
Coal - comm	0.0%	9.9%	-15.9%	54.7%	-19.0%	-12.6%	104.5%	-16.7%
Industrial	0.0%	8.5%	29.6%	-5.4%	22.9%	57.0%	-12.3%	36.9%
Nat. gas - indust	0.0%	27.4%	51.4%	24.7%	50.2%	83.3%	33.3%	65.4%
Petroleum - indust	0.0%	4.8%	24.5%	-10.8%	16.5%	50.8%	-17.9%	34.2%
Coal - indust	0.0%	-18.7%	0.1%	-49.1%	-14.4%	21.2%	-82.8%	-8.5%
Residential	0.0%	17.9%	22.9%	8.4%	16.3%	27.8%	7.7%	17.5%
Nat. gas - res	0.0%	17.1%	21.2%	4.2%	20.6%	26.0%	1.5%	25.4%
Petroleum - res	0.0%	24.8%	39.4%	30.5%	-8.4%	44.9%	36.8%	-32.1%
Coal - res	0.0%	10.1%	-15.8%	55.1%	-18.1%	-12.4%	105.0%	-13.8%
Electric utility sector	0.0%	19.8%	24.0%	24.5%	38.5%	28.9%	40.8%	54.0%
Fossil fuel use, by fuel and sector	0.0%	18.4%	27.3%	23.6%	33.0%	37.2%	37.6%	43.5%
Coal	0.0%	17.4%	22.1%	19.6%	33.5%	27.9%	32.9%	44.9%
Commercial	0.0%	9.9%	-15.9%	54.7%	-19.0%	-12.6%	104.5%	-16.7%
Industrial	0.0%	-18.7%	0.1%	-49.1%	-14.4%	21.2%	-82.8%	-8.5%
Residential	0.0%	10.1%	-15.8%	55.1%	-18.1%	-12.4%	105.0%	-13.8%
Utility	0.0%	19.7%	23.9%	23.3%	37.0%	28.8%	39.0%	48.9%
Petroleum	0.0%	18.7%	31.9%	31.0%	33.2%	45.5%	49.5%	41.1%
Transportation	0.0%	20.3%	32.6%	36.9%	37.1%	45.3%	60.0%	45.0%
Commercial	0.0%	-0.4%	25.8%	-39.2%	12.4%	30.7%	-82.3%	8.8%
Industrial	0.0%	4.8%	24.5%	-10.8%	16.5%	50.8%	-17.9%	34.2%
Residential	0.0%	24.8%	39.4%	30.5%	-8.4%	44.9%	36.8%	-32.1%
Utility	0.0%	24.1%	28.5%	2.4%	-40.7%	33.6%	-21.5%	124.7%
Natural Gas	0.0%	20.2%	28.8%	15.9%	31.3%	39.6%	21.1%	45.6%
Transportation	0.0%	-11.1%	-7.2%	-1.1%	51.3%	-3.5%	9.2%	95.7%
Commercial	0.0%	21.9%	26.2%	21.7%	19.6%	31.2%	32.2%	20.6%
Industrial	0.0%	27.4%	51.4%	24.7%	50.2%	83.3%	33.3%	65.4%
Residential	0.0%	17.1%	21.2%	4.2%	20.6%	26.0%	1.5%	25.4%
Utility	0.0%	37.1%	42.0%	199.3%	268.3%	47.6%	313.7%	754.5%

Part 2: Estimates of CO_2 emissions from future fossil fuel combustion in Missouri's end-use sectors

CO_2 is a natural byproduct of fossil fuel combustion. The quantity of CO_2 emitted depends primarily on the quantity of fuel burned and the carbon content of the fuel. The estimates summarized here make use of the default carbon content coefficients and methods for estimating CO_2 emissions from quantity of fuel documented in the *1990 Inventory*.

Tables 27, 32, 36 and 40 estimate average annual growth rates for future CO_2 emissions in each of the four end-use sectors. These growth rates are for the period from 1996 to 2015. These growth rates do not include those from 1990 to 1996, a period of rapid growth in emissions.

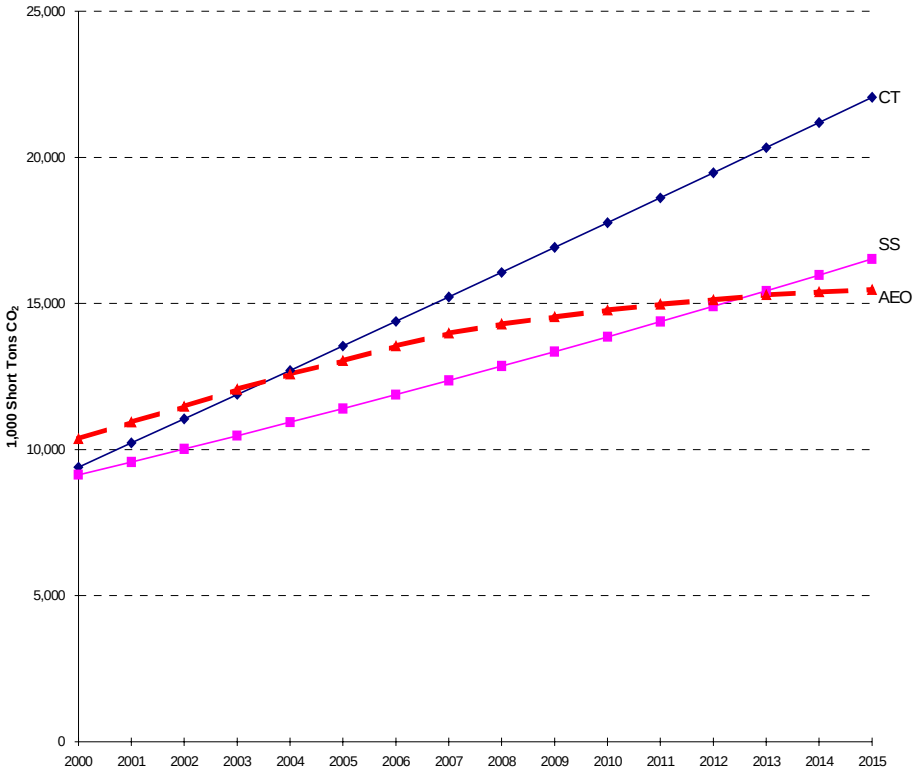
Section 1: Projected CO_2 emissions from fossil fuel combustion in the transportation sector

As Table 27 and Chart 2 illustrate, the CT method projects substantially higher increases in transportation CO_2 emissions than either the SS or AEO method. The CT projection reflects the relatively rapid increase of per capita travel and fuel use in the recent past. The SS method assumes that use of gasoline per capita and diesel and jet fuel per dollar of GSP will remain constant. The AEO projections envision that the rate of increase in per capita emissions will increase more slowly and will eventually decrease as travel behavior changes over time.

Table 27 - Projected growth rate of transportation CO_2 emissions from primary fossil fuel energy use, by method, 1996-2015

	CT	SS	AEO
Transportation	1.5%	1.0%	0.9%
Gasoline	1.0%	0.4%	0.2%
Diesel	2.3%	1.9%	1.6%
Jet fuel	2.5%	1.9%	2.1%
Other	0.1%	0.4%	5.0%

Chart 2 - Projected increase over 1990 baseline of transportation CO_2 emissions from primary fossil fuel use



Projected CO_2 emissions from transportation motor gasoline

As Table 28 and Chart 4 indicate, the *Annual Energy Outlook 1997* anticipates that over the next 20 years technological, economic and demographic trends will lead to a reduction in gasoline use and associated CO_2. The SS and CT methods produce linear projections that do not take such factors into account. The annual average growth rate in gasoline emissions projected by the CT method, 1.1 percent, is about double that projected by the AEO method.

Table 28 - Projected CO_2 emissions from the Missouri transportation sector's use of motor gasoline as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	25,826	27,364	28,488	29,037	29,604	30,186
Continuing Trend	25,826	27,364	29,170	30,646	32,199	33,831
AEO	25,826	27,364	28,803	29,305	29,509	29,332

Chart 3 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of transportation CO_2 emissions from motor gasoline

Projected CO_2 emissions from transportation diesel and jet fuel

As Tables 29 and 30, and Charts 5 and 6 indicate, all scenarios project rapid growth of CO_2 emissions from diesel and jet fuel use in Missouri. However, the *Annual Energy Outlook 1997* anticipates a decline in the growth rate over the next 20 years due to economic changes and improvements in vehicle efficiency.

Table 29 - Projected CO_2 emissions from the Missouri transportation sector's use of diesel fuel as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	7,578	9,423	10,937	12,035	13,243	14,572
Continuing Trend	7,578	9,423	10,835	12,421	14,008	15,595
AEO	7,578	9,423	11,234	12,461	13,204	13,612

Chart 4 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of transportation CO_2 emissions from diesel fuel

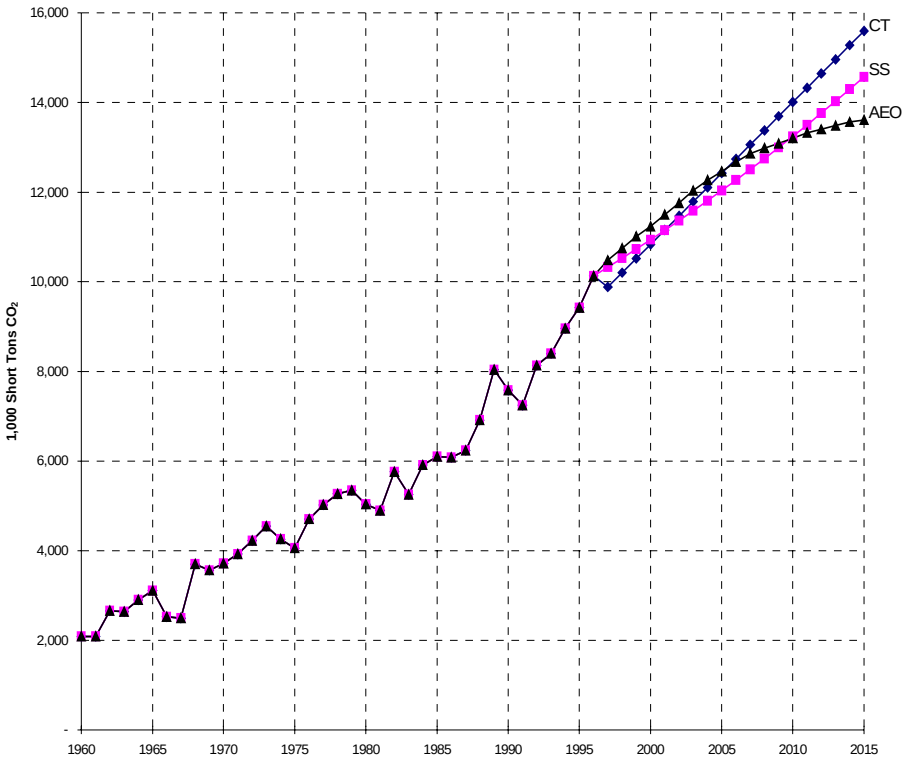
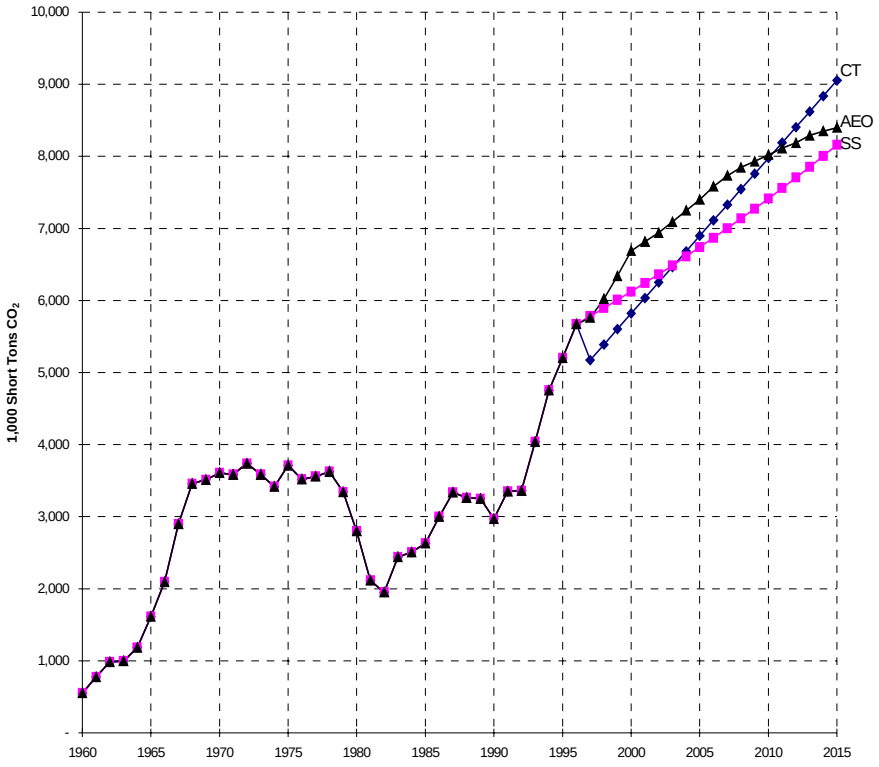


Table 30 - Projected CO_2 emissions from Missouri transportation sector's use of jet fuel as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	2,971	5,204	6,123	6,738	7,414	8,158
Continuing Trend	2,971	5,204	5,819	6,897	7,974	9,052
AEO	2,971	5,204	6,687	7,398	8,022	8,398

Chart 5 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of transportation CO_2 emissions from use of jet fuel



Projected CO_2 emissions from other transportation fuel

Based in part on expectations for technological advance in alternative fuel vehicles and established legal requirements for incorporating them into fleets, USDOE/EIA anticipates that the use of natural gas will double by 2015 and the use of liquid petroleum gas will grow ninefold. Even at this rapid rate of growth, "other fuels" would constitute only 1.7 percent of transportation fuel use, versus 1.1 percent in 1990. The other methods project that in 2015, there will be less use of alternative fuels than in 1990.

Table 31 - Projected CO_2 emissions from transportation use of other petroleum fuel as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	408	360	366	373	380	388
Continuing Trend	408	360	361	362	364	365
AEO	408	360	427	658	818	908

Chart 6 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of transportation CO_2 emissions from other fossil fuel combustion

Section 2: Projected CO_2 emissions from fossil fuel combustion in the commercial sector

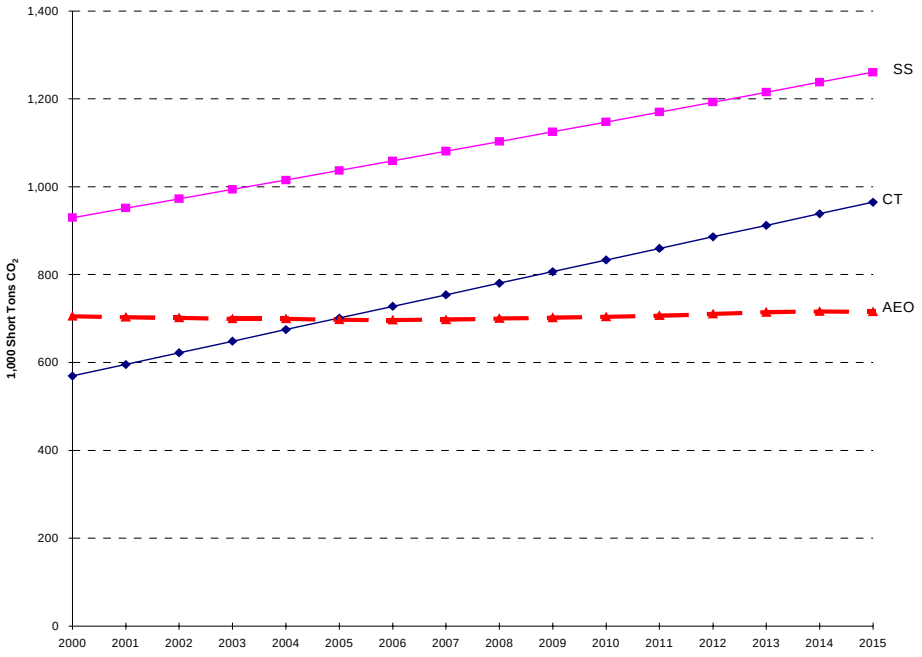
Although CO_2 emissions from primary fossil fuel use in the commercial sector grew by about 18 percent between 1990 and 1996, the CT and AEO analyses projects that emissions will remain nearly constant between 1996 and 2015. Increases illustrated in Chart 8 occurred primarily between 1990 and 1996.

The *Annual Energy Outlook 1997* anticipates little growth in commercial primary fossil fuel energy use between 1996 and 2015 due to slow growth of commercial floor space as well as technological improvements in building shell efficiency and the efficiency of furnaces, boilers and heat pumps fired by natural gas or distillate oil. Increases in commercial energy use will occur primarily in some categories of commercial electricity use.

Table 32 - Projected growth rate of commercial CO_2 emissions from primary fossil fuel energy use, by method, 1996-2015

	CT	SS	AEO
Commercial	0.1%	0.4%	-0.1%
Natural gas	0.4%	0.4%	-0.1%
Petroleum	-9.7%	0.4%	-0.6%
Coal	5.1%	0.5%	0.3%

Chart 7 - Projected increase over 1990 baseline of commercial CO_2 emissions from primary fossil fuel use



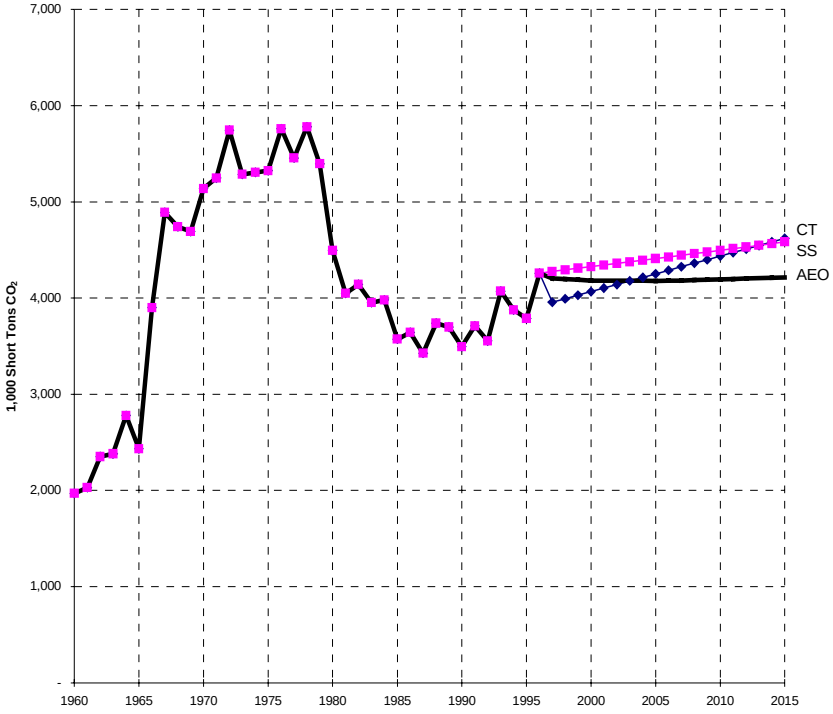
Projected CO_2 emissions from commercial natural gas use

Table 33 - Projected CO_2 emissions from the Missouri commercial sector's use of natural gas as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	3,494	3,788	4,326	4,409	4,495	4,583
Continuing Trend	3,494	3,788	4,066	4,251	4,435	4,620
AEO	3,494	3,788	4,182	4,179	4,193	4,214

Chart 8 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of commercial CO_2 emissions from natural gas



Projected CO_2 emissions from commercial petroleum use

Table 34 - Projected CO_2 emissions from the Missouri commercial sector's use of petroleum as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	721	872	889	906	924	942
Continuing Trend	721	749	593	438	283	127
AEO	721	871	819	810	798	784

Chart 9 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of commercial CO_2 emissions from petroleum

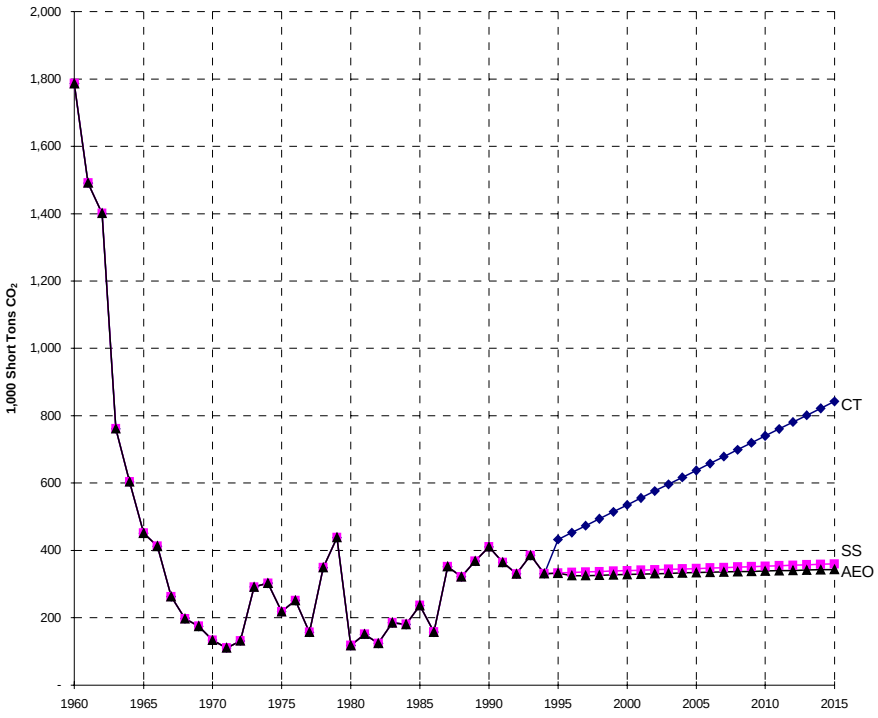
Projected CO_2 emissions from commercial coal use

Table 35 - Projected CO_2 emissions from the Missouri commercial sector's use of coal as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	410	333	340	346	353	360
Continuing Trend	410	432	535	637	740	843
AEO	410	333	328	334	339	343

Chart 10 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of commercial CO_2 emissions from coal



Section 3: Projected CO_2 emissions from fossil fuel combustion in the industrial sector

The *Annual Energy Outlook 1997* projects moderate growth in CO_2 emissions from industrial primary fossil fuel use. The *Annual Energy Outlook* projects a plentiful supply and stable price for natural gas. Industrial uses of petroleum include diesel-powered, off-road equipment.

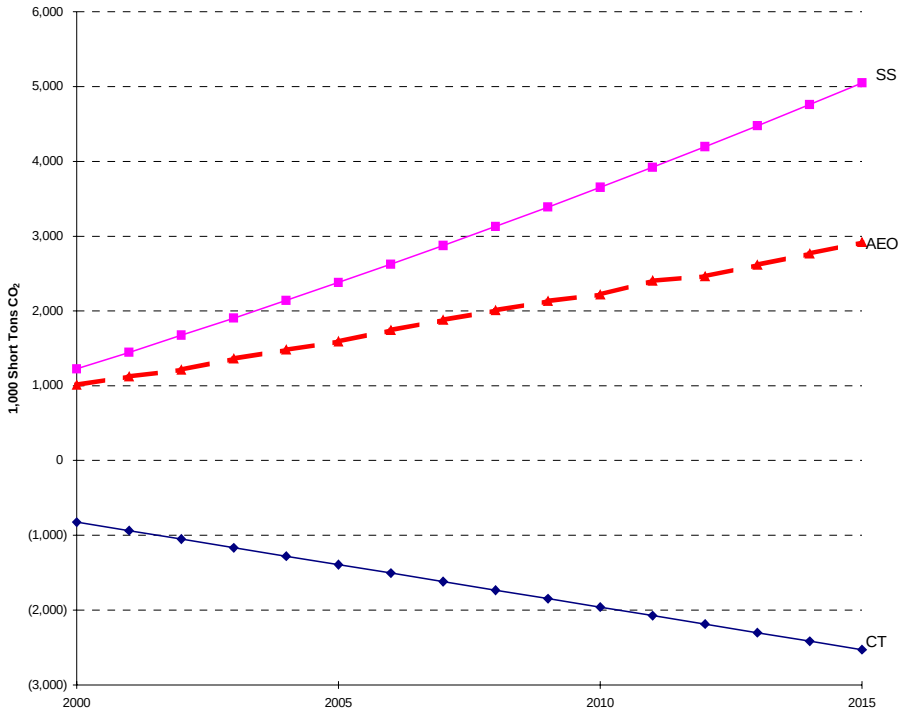
One factor in the *Annual Energy Outlook* projections for industrial CO_2 emissions is the expectation of continued shifts toward less energy-intensive industry. As Chapter 2 points out, this shift may be less a factor in Missouri than elsewhere because the state's industrial sector is already less energy-intensive than the national average.

The SS method projects rapid growth in all fuel types by virtue of its assumption that fuel use in the industrial sectors grows at the rate of GSP. The CT method projects very little change in CO_2 emissions from natural gas use, but decreases in emissions from petroleum and natural gas.

Table 36 - Projected growth rate of industrial CO_2 emissions from primary fossil fuel energy use, by method, 1996-2015

	CT	SS	AEO
Industrial	-1.6%	2.0%	1.2%
Natural gas	0.2%	1.9%	1.4%
Petroleum	-1.5%	1.9%	1.3%
Coal	-7.9%	2.0%	0.5%

Chart 11 - Projected increase over 1990 baseline of industrial CO_2 emissions from primary fossil fuel use



Projected CO_2 emissions from industrial natural gas use

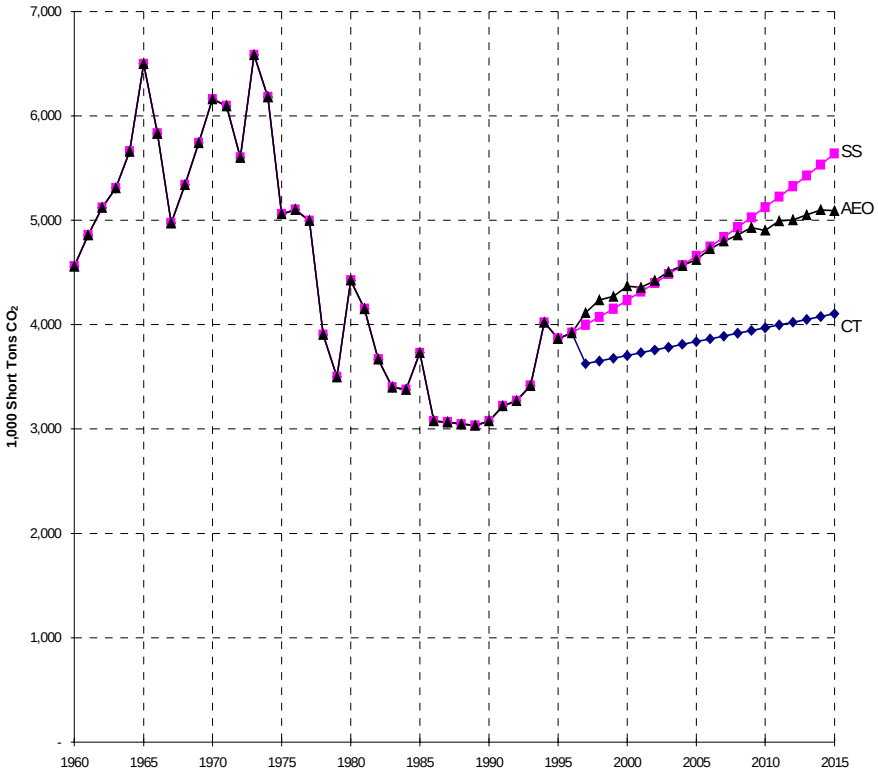
The *Annual Energy Outlook 1997* cites projections for plentiful natural gas supply and stable price as factors that will lead to growth in natural gas consumption by the industry.

Table 37 - Projected CO_2 emissions from the Missouri industrial sector's use of natural gas as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	3,077	3,865	4,233	4,658	5,125	5,640
Continuing Trend	3,077	3,865	3,705	3,838	3,970	4,103
AEO	3,077	3,865	4,369	4,623	4,903	5,091

Chart 12 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of industrial CO_2 emissions from combustion of natural gas



Projected CO_2 emissions from industrial petroleum use

Industrial uses of petroleum include the use of diesel-powered, off-road equipment as well as the use of energy in manufacturing. Non-energy uses of petroleum products such as feedstocks are excluded here but included elsewhere in Chapter 4. The downward trend projected by the CT scenarios is partly an artifact of a downward adjustment in USDOE/EIA estimates for industrial petroleum use between 1990 and 1991.

Table 38 - Projected CO_2 emissions from the Missouri industrial sector's use of petroleum as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	4,107	4,044	4,455	4,903	5,395	5,936
Continuing Trend	4,107	4,044	3,652	3,474	3,296	3,118
AEO	4,107	3,263	3,580	3,985	4,101	4,044

Chart 13 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of industrial CO_2 emissions from combustion of petroleum

Projected CO_2 emissions from industrial coal use

The *Annual Energy Outlook 1997* projects a decrease in CO_2 emissions from coal use due in part to projected changes in steel making technology. The CT projection reflects trends since the 1980s in industrial coal consumption.

Table 39 - Projected CO_2 emissions from the Missouri industrial sector's use of coal as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	3,100	2,563	2,821	3,104	3,415	3,758
Continuing Trend	3,100	2,626	2,102	1,579	1,056	533
AEO	3,100	2,589	2,642	2,655	2,706	2,839

Chart 14 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of industrial CO_2 emissions from combustion of coal

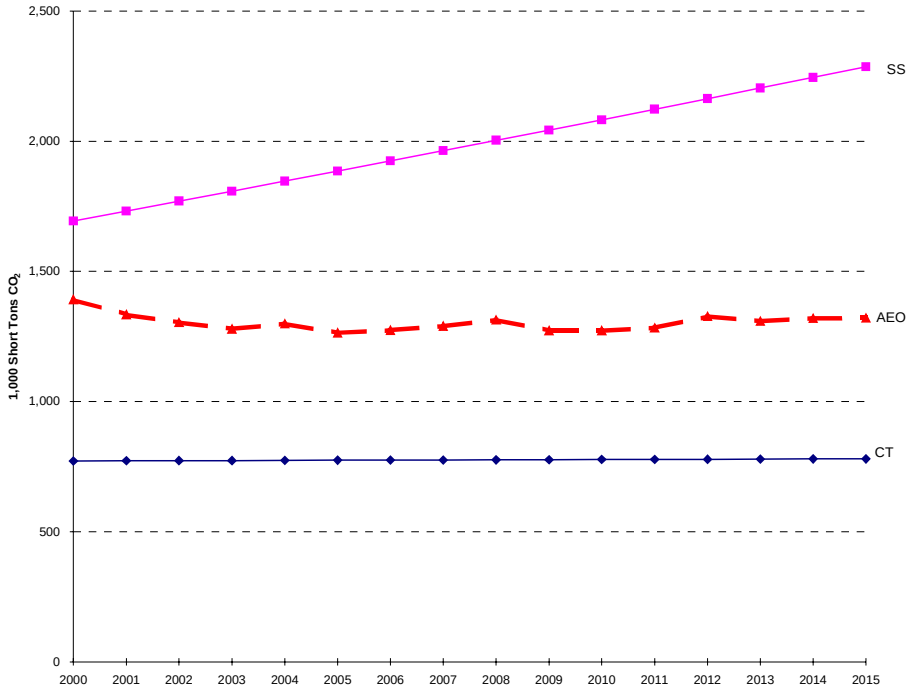
Section 4: Projected CO_2 emissions from fossil fuel combustion in the residential sector

The *Annual Energy Outlook 1997* projects that total CO_2 emissions from residential primary fossil fuel use in 2015 will change little from their level in 1996. The *Annual Energy Outlook* projects that CO_2 emissions from natural gas use will increase due to declining natural gas prices, larger homes and increased use of natural gas heat pumps. However, this increase will be moderated by increased heating efficiency per residential square foot due to building code requirements for new construction. The *Annual Energy Outlook* projects that CO_2 emissions from petroleum use will decrease substantially as residential energy users switch to natural gas or electricity.

Table 40 - Projected growth rate of residential CO_2 emissions from primary fossil fuel energy use, by method, 1996-2015

	CT	SS	AEO
Residential	-0.5%	0.4%	-0.1%
Natural gas	-0.7%	0.4%	0.4%
Petroleum	-0.1%	0.2%	-3.7%
Coal	5.2%	0.6%	0.5%

Chart 15 - Projected increase over 1990 baseline of residential CO_2 emissions from primary fossil fuel use



Projected CO_2 emissions from residential natural gas use

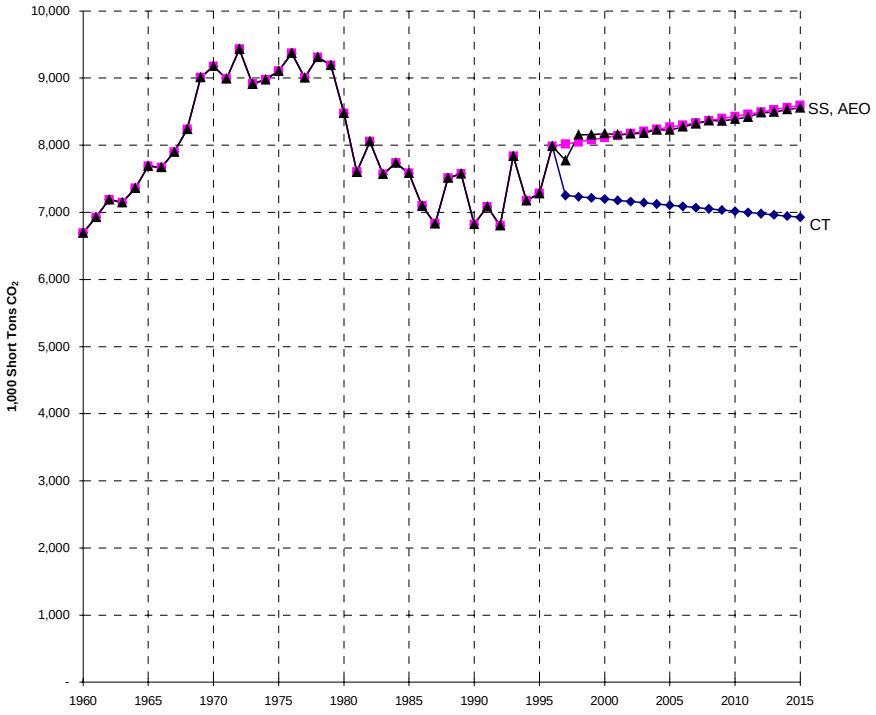
AEO scenarios project that CO_2 emissions from residential natural gas use will increase over the 1996 level of use due to declining natural gas prices, larger homes and increased use of natural gas heat pumps. However, this increase will be moderated by increased heating efficiency per residential square foot due to building code requirements for new construction. The CT scenarios project a decrease from the 1996 consumption level.

Table 41 - Projected CO_2 emissions from the Missouri residential sector's use of natural gas as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	6,822	7,281	8,112	8,269	8,430	8,596
Continuing Trend	6,822	7,281	7,198	7,108	7,017	6,927
AEO	6,822	7,281	8,174	8,225	8,390	8,558

Chart 16 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of residential CO_2 emissions from use of natural gas



Projected CO_2 emissions from residential petroleum use

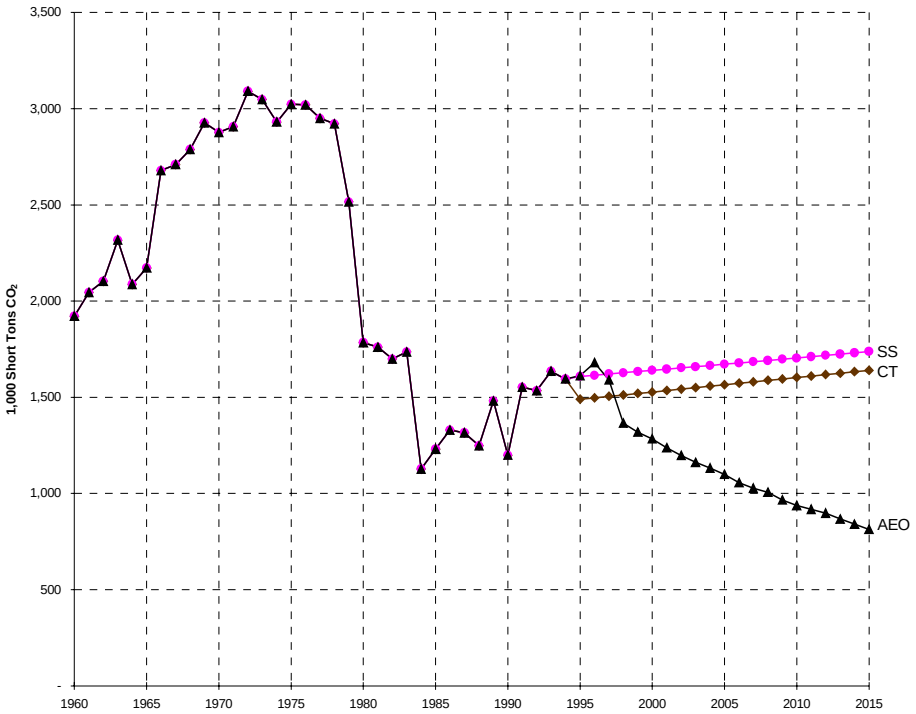
The CT scenario projects a modest increase in residential CO_2 emissions from petroleum use; the AEO scenario projects a decrease as users switch to natural gas or electricity.

Table 42 - Projected CO_2 emissions from the Missouri residential sector's use of petroleum as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	1,200	1,608	1,640	1,672	1,704	1,738
Continuing Trend	1,200	1,490	1,528	1,565	1,603	1,640
AEO	1,200	1,612	1,284	1,099	938	814

Chart 17 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of CO_2 emissions from residential use of petroleum



Projected CO_2 emissions from residential coal use

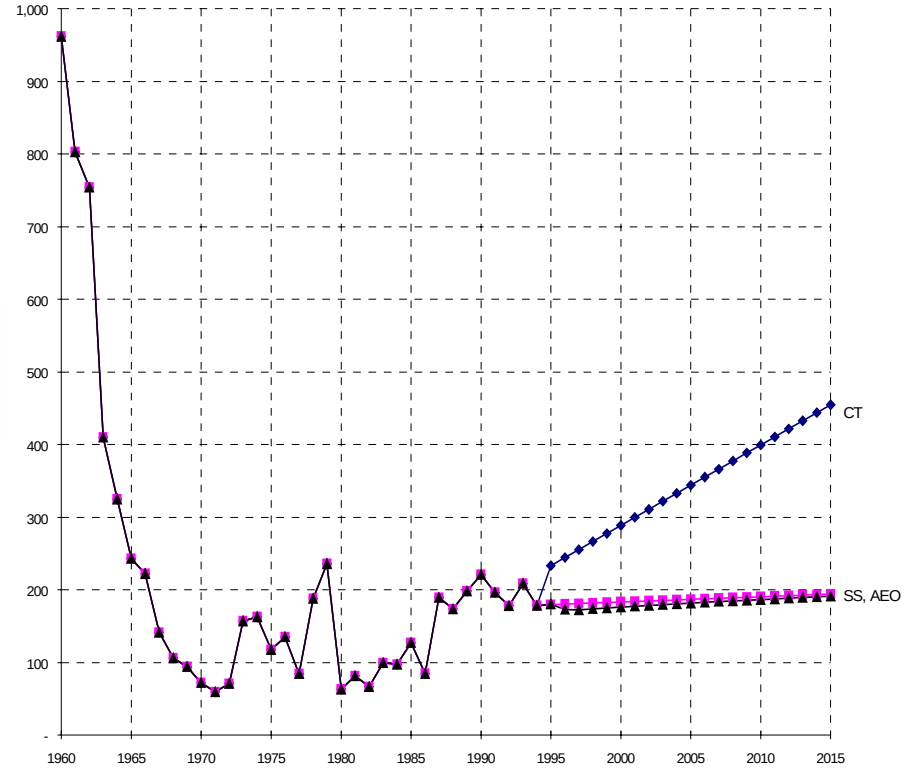
The CT scenario projects a modest increase in residential CO_2 emissions from coal use; the AEO scenario projects a decrease as users switch to natural gas or electricity.

Table 43 - Projected CO_2 emissions from the Missouri residential sector's use of coal as an energy source, by scenario

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1995	2000	2005	2010	2015
Steady State	221	180	183	187	191	194
Continuing Trend	221	233	289	344	399	455
AEO	221	180	176	182	187	191

Chart 18 - Steady State (SS), Continuing Trend (CT) and AEO scenario projections of CO_2 emissions from residential use of coal



Section 5: Mix and distribution of CO_2 emissions from coal, petroleum and natural gas use in the end-use sectors

Table 44 summarizes projected increases in end-use sector CO_2 emissions for the periods from 1995 to 2005 and 2005 to 2015. The projections indicate that increases in CO_2 emissions from petroleum use, primarily in the transportation sector,[12] will be the main contributor to the growth of end-use sector emissions.

Table 44 - Projected increase in CO_2 emissions from fossil fuel combustion in Missouri's end-use sectors, by fuel

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	Increase 1995 to 2005			Increase 2005 to 2015		
End-use sectors	**CT**	**SS**	**AEO**	**CT**	**SS**	**AEO**
Natural Gas	262	2,401	2,093	454	3,622	2,666
Petroleum	6,927	6,786	7,447	7,924	6,116	3,316
Coal	-541	535	69	-731	1,752	813
Total	6,647	9,723	9,609	7,648	11,490	6,795
10-year rate of growth	***1.0%***	***1.4%***	***1.4%***	***1.0%***	***1.5%***	***0.9%***

One striking result from this summary is that the AEO method projects a slowdown in the growth rate of end-use sector emissions. The AEO method projects a 1.4 percent growth rate for the period from 1995 to 2005 and only a 0.9 percent growth rate for the period from 2005 to 2015. The projected slowdown occurs in the transportation sector, where the *Annual Energy Outlook 1997* expects decreasing growth in transportation fuel use throughout the projection period and an absolute reduction in gasoline use from 2010 to 2015.

[12] The AEO and SS methods also project significant industrial sector increases in CO_2 emissions from petroleum from 2005 to 2015.

Part 3: Scenario estimates of future CO_2 emissions from fossil fuel combustion in all sectors, allocating utility CO_2 emissions to the four end-use sectors

Section 1: Allocation of utility CO_2 emissions to end-use sectors

CO_2 emissions generated by utilities and allocated to the commercial sector accounted for about 80 percent of that sector's total energy-based CO_2 emissions in 1990. The corresponding percentages for the residential and industrial sectors in 1990 were 72 percent and 55 percent. As Table 45 indicates, these percentage shares will probably increase over the next 20 years, reaching 83 to 87 percent for the commercial sector, 75 to 79 percent for the residential sector and 59 to 69 percent for the industrial sector.

Table 45 - Emissions related to electricity use as a portion of total CO_2 emissions in three end-use sectors, 1990, 2005 and 2015

	Commercial sector		Residential sector		Industrial sector	
	1990	2015	1990	2015	1990	2015
CT Sales (LowNG)	80.0%	86.8%	71.5%	79.4%	54.6%	68.7%
CT Sales (HighNG)		85.9%		78.1%		67.1%
CT (direct)		84.6%		76.3%		64.7%
AEO Sales (LowNG)		84.5%		76.6%		60.6%
AEO (direct)		84.5%		76.6%		60.4%
AEO Sales (HighNG)		83.4%		75.1%		58.5%

Following the example of the *1990 Inventory*, this study allocates projected utility CO_2 emissions to end users based on their projected use of electricity, measured by electricity sales. Through 2015, the residential, commercial and industrial sectors will continue to be the major users of electricity generated from fossil fuel combustion in Missouri's utility sector. As Table 46 indicates, electricity sales to the residential, commercial and industrial sectors are projected to grow through 2015. However, in most cases, the rate of growth will slow after 2005; the exception is the AEO projection of electricity sales to the residential sector.

Table 46 - Projected average annual growth rate of electricity sales, by sector, 1996-2005 and 2005-2015

		Resid.	Comm.	Indust.	Total
AEO electricity sales	1996-2005	0.9%	1.4%	2.0%	1.4%
	2005-2015	1.1%	1.0%	1.5%	1.2%
CT electricity sales	1996-2005	1.9%	2.6%	1.1%	2.0%
	2005-2015	1.6%	2.1%	1.0%	1.7%

Sector shares of total electricity consumption have changed in the past and will continue to change in the future. Table 47 shows the estimated sector shares from 1960 to 2015. These shares were used to allocate projected utility emissions to the different end-use sectors.

Table 47 - Estimated commercial, industrial and residential share of total electricity consumption in Missouri, based on three approaches, 1960-2015

	CT projected sector shares			AEO projected sector shares			SS projected sector shares		
	Comm.	Ind.	Resid.	Comm.	Ind.	Resid.	Comm.	Ind.	Resid.
1960	29%	34%	37%	29%	34%	37%	29%	34%	37%
1990	36%	24%	40%	36%	24%	40%	36%	24%	40%
1995	36%	23%	41%	36%	23%	41%	36%	23%	41%
2000	38%	22%	40%	36%	24%	40%	37%	23%	40%
2005	39%	21%	40%	37%	24%	39%	38%	23%	40%
2010	40%	20%	40%	37%	25%	39%	38%	22%	39%
2015	41%	20%	40%	36%	25%	39%	38%	22%	39%

The sales projections underlying Tables 46 and 47 are based on three different approaches to estimating sector shares of electricity sales — the CT, AEO and SS methods.

- The CT approach to estimating sector shares is based on trend projection of Missouri electricity sales to the three sectors between 1980 and 1996, and projects that the residential and commercial sectors will account for 80 percent of all electricity sales in 2015. Per capita use of electricity in Missouri's residential and commercial sectors rose from 1980 to 1996, whereas electricity use per dollar of GSP declined in Missouri's industrial sector. The CT method projects that these trends will continue.

- The AEO approach to estimating sector shares is based on *Annual Energy Outlook 1997* projections for the North West Central region and projects that the residential and commercial sectors will account for 75 percent of all electricity sales in 2015. Both the projected increase in residential and commercial per capita sales, and the projected decline in industrial sales per GSP, are more moderate than those estimated by the CT method. As Chapter 2 points out, since Missouri industry is already less energy-intensive than the U.S. average, the AEO projection for industrial sales may be more realistic. On the other hand, the AEO projection for residential and commercial electricity sales assumes that sales will be moderated by efficiency gains and market saturation of current appliances. As Chapter 2 points out, the introduction of new uses for electricity, rapid economic growth, or lower electricity prices resulting from market restructuring could push residential and commercial sales upward toward the CT estimate.

- Since the SS method was not used to estimate electricity sales, there is no independent SS estimate for the distribution of electricity sales by sector. Therefore, the average of the AEO and CT estimates is used to allocate utility CO_2 emissions across end-use sectors.

Table 48 summarizes the projections of energy-based CO_2 emissions in 2015 that result when the sector shares in Table 47 are used as the basis for allocating electricity emissions to Missouri's four end-use sectors. The table indicates the relative shares of allocated utility emissions and emissions from primary fossil fuel use in 2015.

Table 48 - Projected total energy-based CO_2 emissions in Missouri, by end-use sector and estimation method, 2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1990	1996	CT direct estimate	CT Sales LowNG	CT Sales HighNG	AEO direct estimate	AEO Sales LowNG	AEO Sales HighNG	SS direct estimate
Transportation	36,782	44,208	58,842	58,842	58,842	52,250	52,250	52,250	53,303
Gasoline	25,826	28,044	33,831	33,831	33,831	29,332	29,332	29,332	30,186
Diesel	7,578	10,131	15,595	15,595	15,595	13,612	13,612	13,612	14,572
Jet	2,971	5,672	9,052	9,052	9,052	8,398	8,398	8,398	8,158
Other	408	360	365	365	365	908	908	908	388
Commercial	23,104	29,089	36,275	42,391	39,696	34,408	34,556	32,153	32,208
Electricity	18,479	23,625	30,685	36,801	34,106	29,067	29,215	26,812	26,322
Nat. Gas	3,494	4,258	4,620	4,620	4,620	4,214	4,214	4,214	4,583
Petroleum	721	881	127	127	127	784	784	784	942
Coal	410	325	843	843	843	343	343	343	360
Industrial	22,649	24,927	21,962	24,794	23,546	33,371	33,474	31,807	30,630
Electricity	12,365	14,314	14,208	17,040	15,792	20,170	20,273	18,605	15,297
Nat. Gas	3,077	3,921	4,103	4,103	4,103	5,091	5,091	5,091	5,640
Petroleum	4,107	4,127	3,118	3,118	3,118	5,272	5,272	5,272	5,936
Coal	3,100	2,564	533	533	533	2,839	2,839	2,839	3,758
Residential	28,937	35,187	38,023	43,803	41,255	40,793	40,952	38,370	37,425
Electricity	20,694	25,349	29,000	34,780	32,233	31,230	31,389	28,807	26,897
Nat. Gas	6,822	7,986	6,927	6,927	6,927	8,558	8,558	8,558	8,596
Petroleum	1,200	1,680	1,640	1,640	1,640	814	814	814	1,738
Coal	221	173	455	455	455	191	191	191	194
Total	***111,472***	***133,411***	***155,102***	***169,830***	***163,339***	***160,822***	***161,233***	***154,580***	***153,566***

Tables 49 through 52 summarize projected emissions for the transportation, industrial, residential and commercial sectors. These tables also indicate the annual average growth rates of CO_2 emissions for 1990 to 2015, 1996 to 2005 and 2005 to 2015. Examination of the projected growth rates in these tables and Table 5 leads to the following conclusions:

1. Over the next 20 years, CO_2 emissions from fossil fuel combustion will probably not grow as rapidly as they did during 1990 to 1996, when they grew at a brisk 3.1 percent average annual rate.

2. In most cases, the growth rate of CO_2 emissions from fossil fuel combustion will gradually decrease. The deceleration in the rate of emissions increase is most pronounced for the AEO-based scenarios than the CT-based scenarios.

3. Both the CT and AEO methods project an accelerating rate of emissions in the residential sector.

Table 49 - Projected CO_2 emissions from fossil fuel combustion in Missouri's industrial sector, by scenario – including utility CO_2 emissions allocated in proportion to projected industrial electricity use, 1990-2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

		Projected CO_2 emissions, including allocated utility emissions						Average annual growth rate		
		1990	1996	2000	2005	2010	2015	1990-2015	1996-2005	2005-2015
Low	SS direct	22,649	24,989	26,216	27,570	29,035	30,630			
	AEO sales HighNG	22,649	24,985	26,890	28,853	30,671	31,807	1.37%	1.61%	0.98%
	CT direct	22,649	24,927	22,727	22,444	22,191	21,962	-0.12%	-1.16%	-0.22%
Mid	AEO direct	22,649	24,985	28,367	29,626	30,753	33,371	1.56%	1.91%	1.20%
	AEO sales LowNG	22,649	24,985	26,953	29,129	31,265	33,474	1.57%	1.72%	1.40%
	CT sales HighNG	22,649	24,927	23,692	23,904	24,031	23,546	0.16%	-0.46%	-0.15%
High	CT sales LowNG	22,649	24,927	23,752	24,153	24,535	24,794	0.36%	-0.35%	0.26%

Table 50 - Projected CO_2 emissions from fossil fuel combustion in Missouri's residential sector, by scenario – including utility CO_2 emissions allocated in proportion to projected residential electricity use, 1990-2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

		Projected CO_2 emissions, including allocated utility emissions						Average annual growth rate		
		1990	1996	2000	2005	2010	2015	1990-2015	1996-2005	2005-2015
Low	SS direct	28,937	35,540	35,964	36,206	36,717	37,425			
	AEO sales HighNG	28,937	35,768	36,307	36,930	37,980	38,370	1.14%	0.36%	0.38%
	CT direct	28,937	35,187	33,381	34,921	36,469	38,023	1.10%	-0.08%	0.85%
Mid	AEO direct	28,937	35,768	38,832	38,178	38,109	40,793	1.38%	0.73%	0.66%
	AEO sales LowNG	28,937	35,768	36,415	37,376	38,912	40,952	1.40%	0.49%	0.92%
	CT sales HighNG	28,937	35,187	35,152	37,711	40,111	41,255	1.43%	0.77%	0.90%
High	CT sales LowNG	28,937	35,187	35,262	38,187	41,108	43,803	1.67%	0.91%	1.38%

Table 51 - Projected CO_2 emissions from fossil fuel combustion in Missouri's commercial sector, by scenario – including utility CO_2 emissions allocated in proportion to projected commercial electricity use, 1990-2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

		Projected CO_2 emissions, including allocated utility emissions						Average annual growth rate		
		1990	1996	2000	2005	2010	2015	1990-2015	1996-2005	2005-2015
Low	SS direct	23,104	28,674	29,482	30,587	31,476	32,208	1.34%	0.72%	0.52%
	AEO sales HighNG	23,104	28,450	29,075	30,891	32,174	32,153	1.33%	0.92%	0.40%
	CT direct	23,104	29,089	28,733	31,282	33,793	36,275	1.82%	0.81%	1.49%
Mid	AEO direct	23,105	28,450	31,323	32,055	32,295	34,408	1.61%	1.33%	0.71%
	AEO sales LowNG	23,105	28,450	29,171	31,306	33,052	34,556	1.62%	1.07%	0.99%
	CT sales HighNG	23,104	29,089	30,444	34,078	37,552	39,696	2.19%	1.77%	1.54%
High	CT sales LowNG	23,104	29,089	30,550	34,554	38,582	42,391	2.46%	1.93%	2.07%

Table 52 - Projected CO_2 emissions from fossil fuel combustion in Missouri's transportation sector, by scenario, 1990-2015

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

		Projected CO_2 emissions, including allocated utility emissions						Average annual growth rate		
		1990	1996	2000	2005	2010	2015	1990-2015	1996-2005	2005-2015
Low	SS direct	36,782	44,208	45,915	48,183	50,641	53,303	1.49%	0.96%	1.02%
	AEO sales HighNG	36,782	44,207	47,150	49,821	51,554	52,250	1.41%	1.34%	0.48%
	CT direct	36,782	44,208	46,185	50,326	54,545	58,842	1.90%	1.45%	1.58%
Mid	AEO direct	36,782	44,207	47,150	49,821	51,554	52,250	1.41%	1.34%	0.48%
	AEO sales LowNG	36,782	44,207	47,150	49,821	51,554	52,250	1.41%	1.34%	0.48%
	CT sales HighNG	36,782	44,208	46,185	50,326	54,545	58,842	1.90%	1.45%	1.58%
High	CT sales LowNG	36,782	44,208	46,185	50,326	54,545	58,842	1.90%	1.45%	1.58%

Section 2: Scenario projections of increases in CO_2 emissions over the 1990 baseline

Because many proposals for reducing greenhouse gas emissions set targets related to the level of emissions in 1990, it is relevant to summarize projected increases in Missouri's CO_2 emissions relative to Missouri's 1990 emissions baseline.

Tables 53 through 56, together with Charts 20 through 23, give projections for each end-use sector. The projections include utility emissions allocated according to each sector's projected consumption of electricity, and are organized around the low-, midrange- and high-CO_2 scenarios developed in this chapter and Chapter 2. The tables list the seven scenario methods in the same order that they are listed in Table 5 — from low to high total CO_2 emissions.

For each scenario method, the tables provide the annual average growth rate of CO_2 emissions between 1996 and 2015. This provides a bottom-line measure of projected future growth in CO_2 emissions.

The tables also provide annual average growth rates for 1990 to 1996 and each subsequent five-year growth period. Comparing the sequence of five-year growth rates indicates the pattern of growth projected for any given scenario.

Projected increases in commercial CO_2 emissions

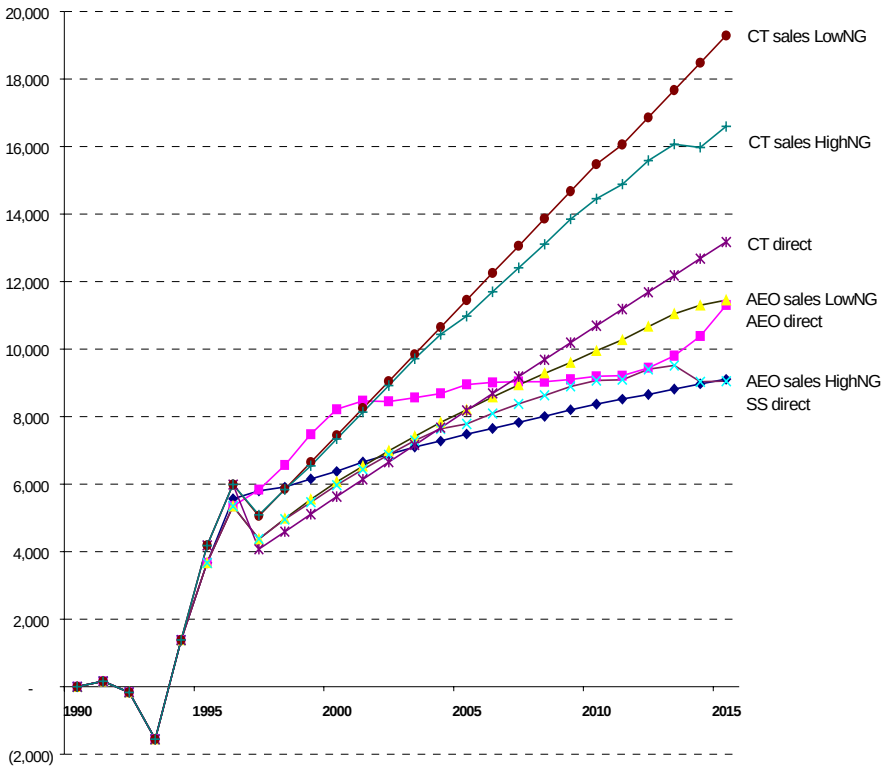
Table 53 - Missouri commercial CO_2 emissions from fossil fuel combustion and use of electricity, 1990-2015 — projected increase over 1990 baseline

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1996	2000	2005	2010	2015	Growth rate 1996-2015
SS direct	5,570	6,378	7,482	8,372	9,103	0.61%
AEO sales HighNG	5,346	5,970	7,786	9,070	9,048	0.65%
CT direct	5,985	5,628	8,178	10,689	13,171	1.17%
AEO direct	5,345	8,218	8,950	9,191	11,303	1.01%
AEO sales LowNG	5,345	6,066	8,201	9,948	11,451	1.03%
CT sales HighNG	5,985	7,339	10,973	14,448	16,591	1.65%
CT sales LowNG	5,985	7,445	11,450	15,478	19,287	2.00%

	Growth rate 1990-1996	Growth rate 1996-2000	Growth rate 2000-2005	Growth rate 2005-2010	Growth rate 2010-2015
SS direct	3.67%	0.70%	0.74%	0.57%	0.46%
AEO sales HighNG	3.53%	0.54%	1.22%	0.82%	-0.01%
CT direct	3.91%	-0.31%	1.71%	1.56%	1.43%
AEO direct	3.53%	2.43%	0.46%	0.15%	1.28%
AEO sales LowNG	3.53%	0.63%	1.42%	1.09%	0.89%
CT sales HighNG	3.91%	1.14%	2.28%	1.96%	1.12%
CT sales LowNG	3.91%	1.23%	2.49%	2.23%	1.90%

Chart 19 - Missouri commercial CO_2 emissions from fossil fuel combustion and use of electricity, 1990-2015 — projected increase over 1990 baseline



Projected increases in industrial CO_2 emissions

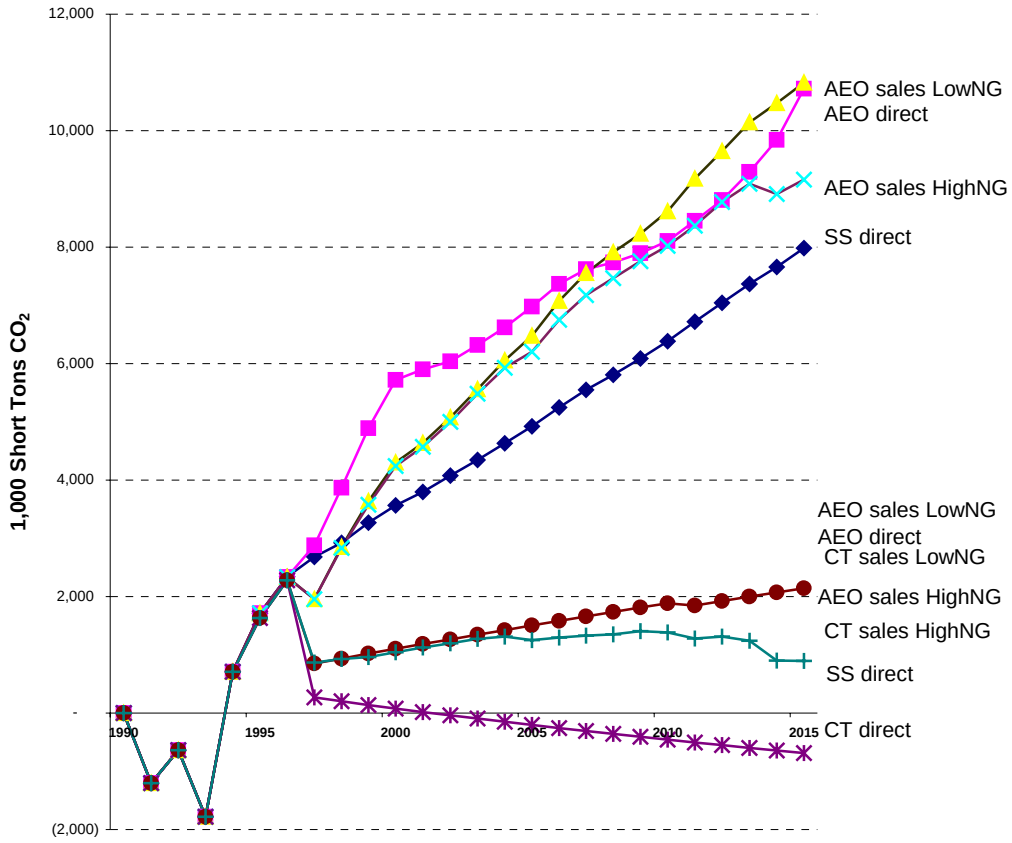
Table 54 - Missouri industrial CO_2 emissions from fossil fuel combustion and use of electricity, 1990-2015 — projected increase over 1990 baseline

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1996	2000	2005	2010	2015	Growth rate 1996-2015
SS direct	2,340	3,567	4,921	6,386	7,982	1.08%
AEO sales HighNG	2,336	4,241	6,204	8,022	9,158	1.28%
CT direct	2,278	79	(205)	(457)	(686)	-0.66%
AEO direct	2,336	5,718	6,977	8,104	10,722	1.53%
AEO sales LowNG	2,336	4,304	6,480	8,616	10,825	1.55%
CT sales HighNG	2,278	1,043	1,255	1,382	897	-0.30%
CT sales LowNG	2,278	1,103	1,504	1,887	2,145	-0.03%

	Growth rate 1990-1996	Growth rate 1996-2000	Growth rate 2000-2005	Growth rate 2005-2010	Growth rate 2010-2015
SS direct	1.65%	1.21%	1.01%	1.04%	1.08%
AEO sales HighNG	1.65%	1.85%	1.42%	1.23%	0.73%
CT direct	1.61%	-2.28%	-0.25%	-0.23%	-0.21%
AEO direct	1.65%	3.22%	0.87%	0.75%	1.65%
AEO sales LowNG	1.65%	1.91%	1.57%	1.43%	1.37%
CT sales HighNG	1.61%	-1.26%	0.18%	0.11%	-0.41%
CT sales LowNG	1.61%	-1.20%	0.34%	0.31%	0.21%

Chart 20 - Missouri industrial CO_2 emissions from fossil fuel combustion and use of electricity, 1990-2015 — projected increase over 1990 baseline



Projected increases in residential CO_2 emissions

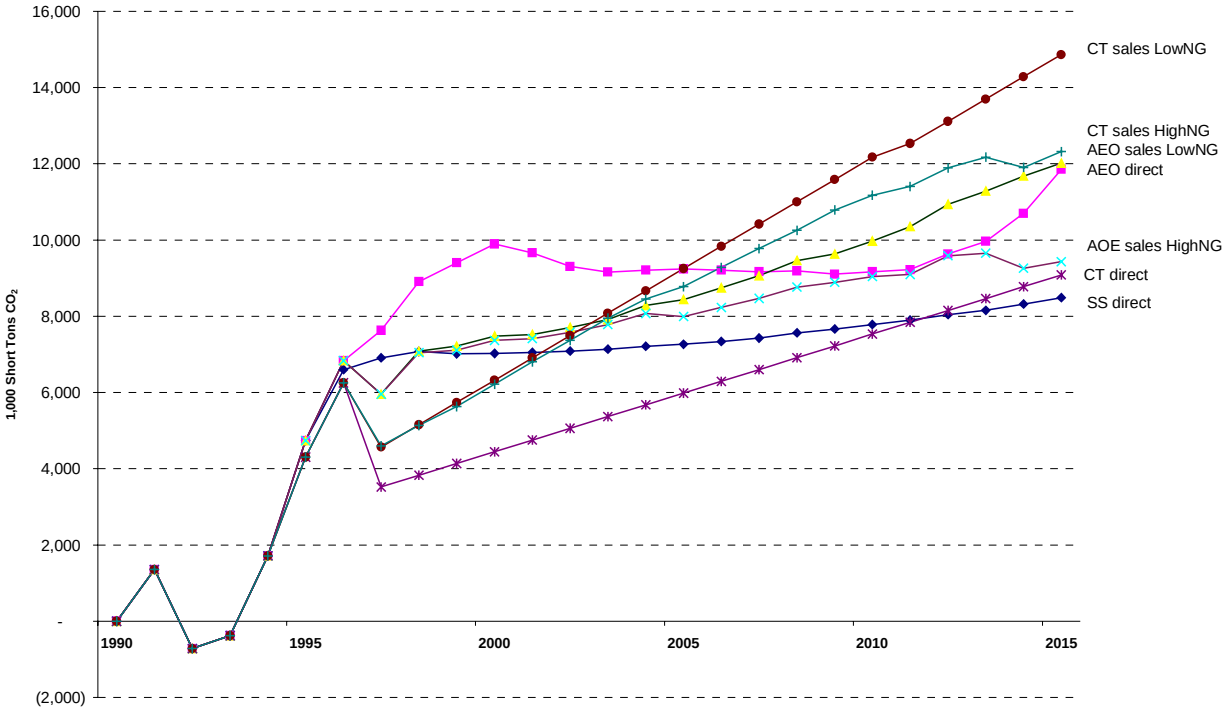
Table 55 - Missouri residential CO_2 emissions from fossil fuel combustion and use of electricity, 1990-2015 — projected increase over 1990 baseline

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1996	2000	2005	2010	2015	Growth rate 1996-2015
SS direct	6,603	7,027	7,270	7,780	8,488	0.27%
AEO sales HighNG	6,831	7,370	7,993	9,044	9,434	0.37%
CT direct	6,251	4,444	5,985	7,533	9,086	0.41%
AEO direct	6,831	9,895	9,241	9,172	11,856	0.69%
AEO sales LowNG	6,831	7,478	8,439	9,975	12,015	0.71%
CT sales HighNG	6,251	6,215	8,775	11,174	12,319	0.84%
CT sales LowNG	6,251	6,325	9,251	12,172	14,866	1.16%

	Growth rate 1990-1996	Growth rate 1996-2000	Growth rate 2000-2005	Growth rate 2005-2010	Growth rate 2010-2015
SS direct	3.49%	0.30%	0.13%	0.28%	0.38%
AEO sales HighNG	3.60%	0.37%	0.34%	0.56%	0.20%
CT direct	3.31%	-1.31%	0.91%	0.87%	0.84%
AEO direct	3.60%	2.08%	-0.34%	-0.04%	1.37%
AEO sales LowNG	3.60%	0.45%	0.52%	0.81%	1.03%
CT sales HighNG	3.31%	-0.03%	1.42%	1.24%	0.56%
CT sales LowNG	3.31%	0.05%	1.61%	1.49%	1.28%

Chart 21 - Missouri residential CO_2 emissions from fossil fuel combustion and use of electricity, 1990-2015 — projected increase over 1990 baseline



Projected increases in CO_2 emissions from transportation

Table 56 - Missouri transportation sector CO_2 emissions from fossil fuel combustion, 1990-2015 — projected increase over 1990 baseline

Units: 1,000 Short Tons Carbon Dioxide (CO_2)

	1996	2000	2005	2010	2015
SS direct	7,425	9,132	11,401	13,859	16,521
AEO sales HighNG	7,424	10,368	13,039	14,771	15,468
CT direct	7,425	9,403	13,544	17,763	22,059
AEO direct	7,424	10,368	13,039	14,771	15,468
AEO sales LowNG	7,424	10,368	13,039	14,771	15,468
CT sales HighNG	7,425	9,403	13,544	17,763	22,059
CT sales LowNG	7,425	9,403	13,544	17,763	22,059

	Growth rate 1990-1996	Growth rate 1996-2000	Growth rate 2000-2005	Growth rate 2005-2010	Growth rate 2010-2015
SS direct	3.11%	0.95%	0.97%	1.00%	1.03%
AEO sales HighNG	3.11%	1.62%	1.11%	0.69%	0.27%
CT direct	3.11%	1.10%	1.73%	1.62%	1.53%
AEO direct	3.11%	1.62%	1.11%	0.69%	0.27%
AEO sales LowNG	3.11%	1.62%	1.11%	0.69%	0.27%
CT sales HighNG	3.11%	1.10%	1.73%	1.62%	1.53%
CT sales LowNG	3.11%	1.10%	1.73%	1.62%	1.53%

Chart 22 - Missouri transportation sector CO_2 emissions from fossil fuel combustion, 1990-2015 — projected increase over 1990 baseline